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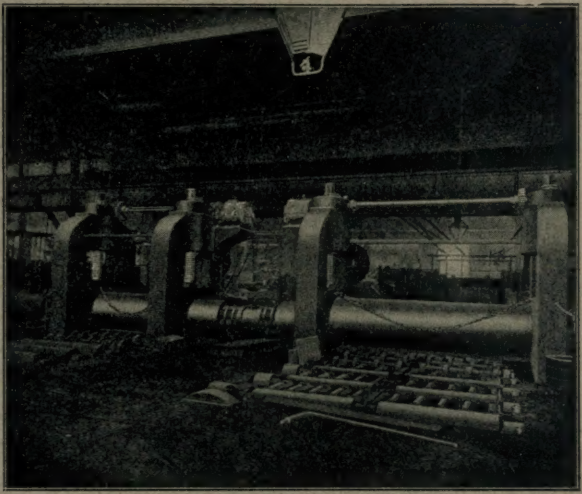

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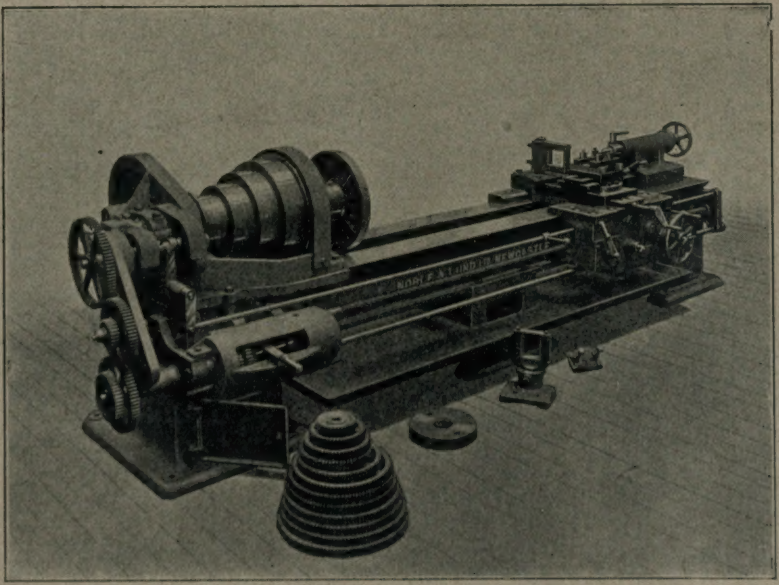

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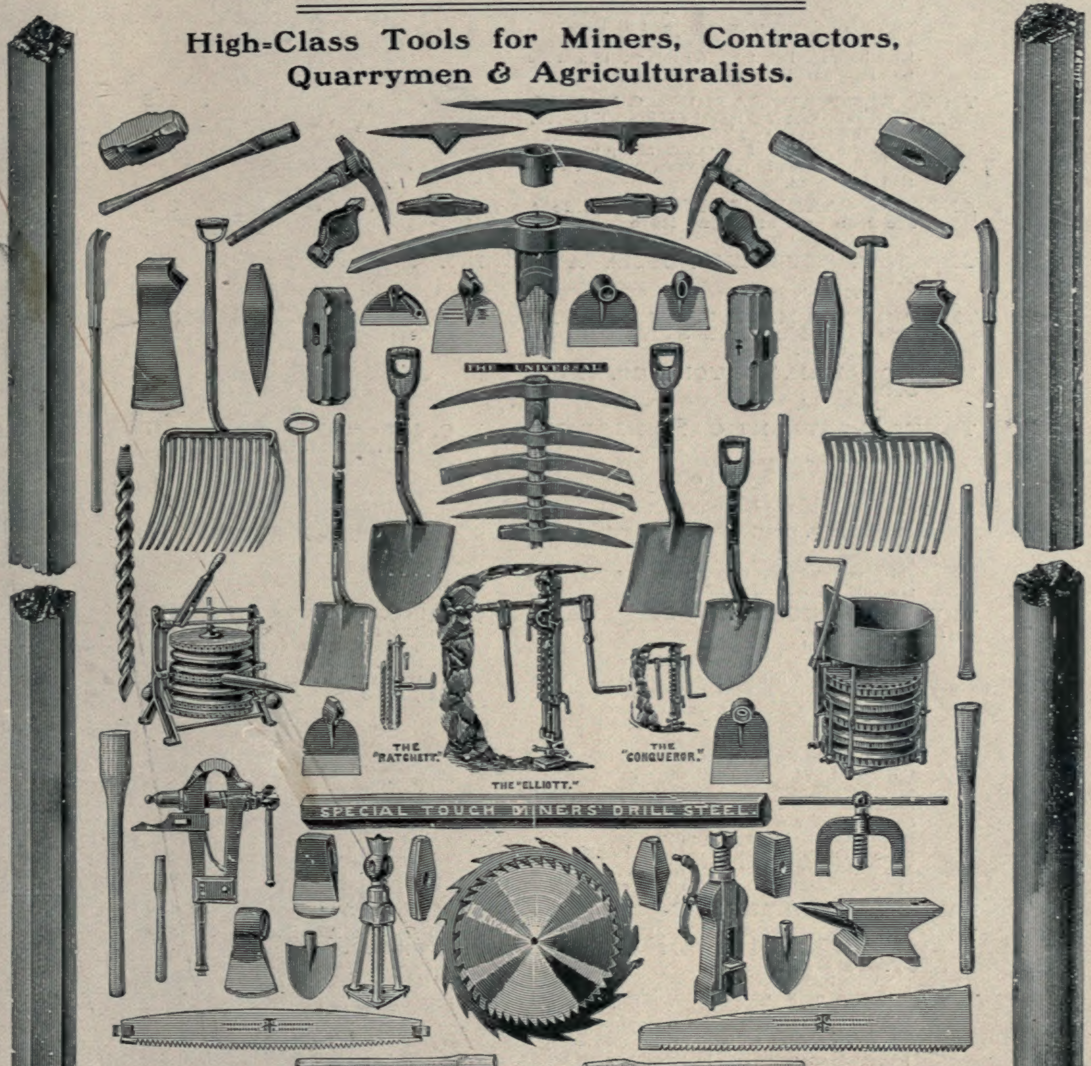
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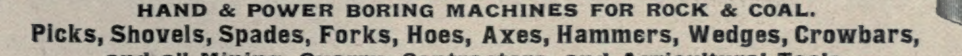

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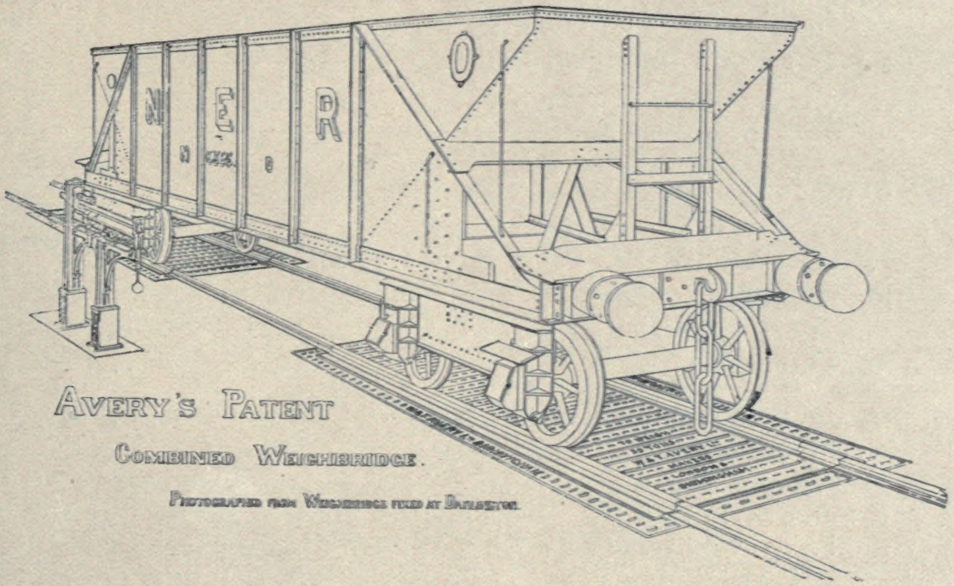

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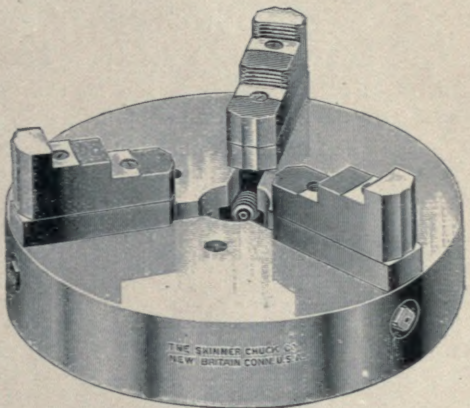
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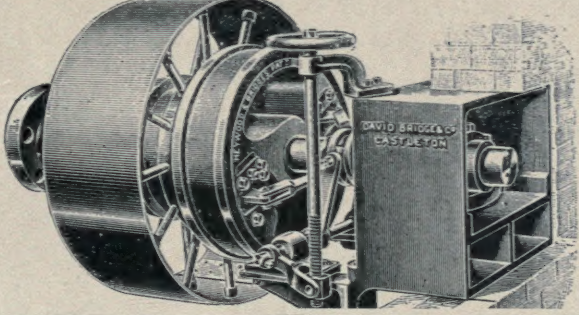

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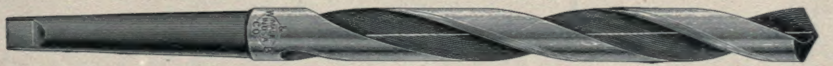

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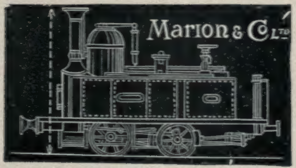

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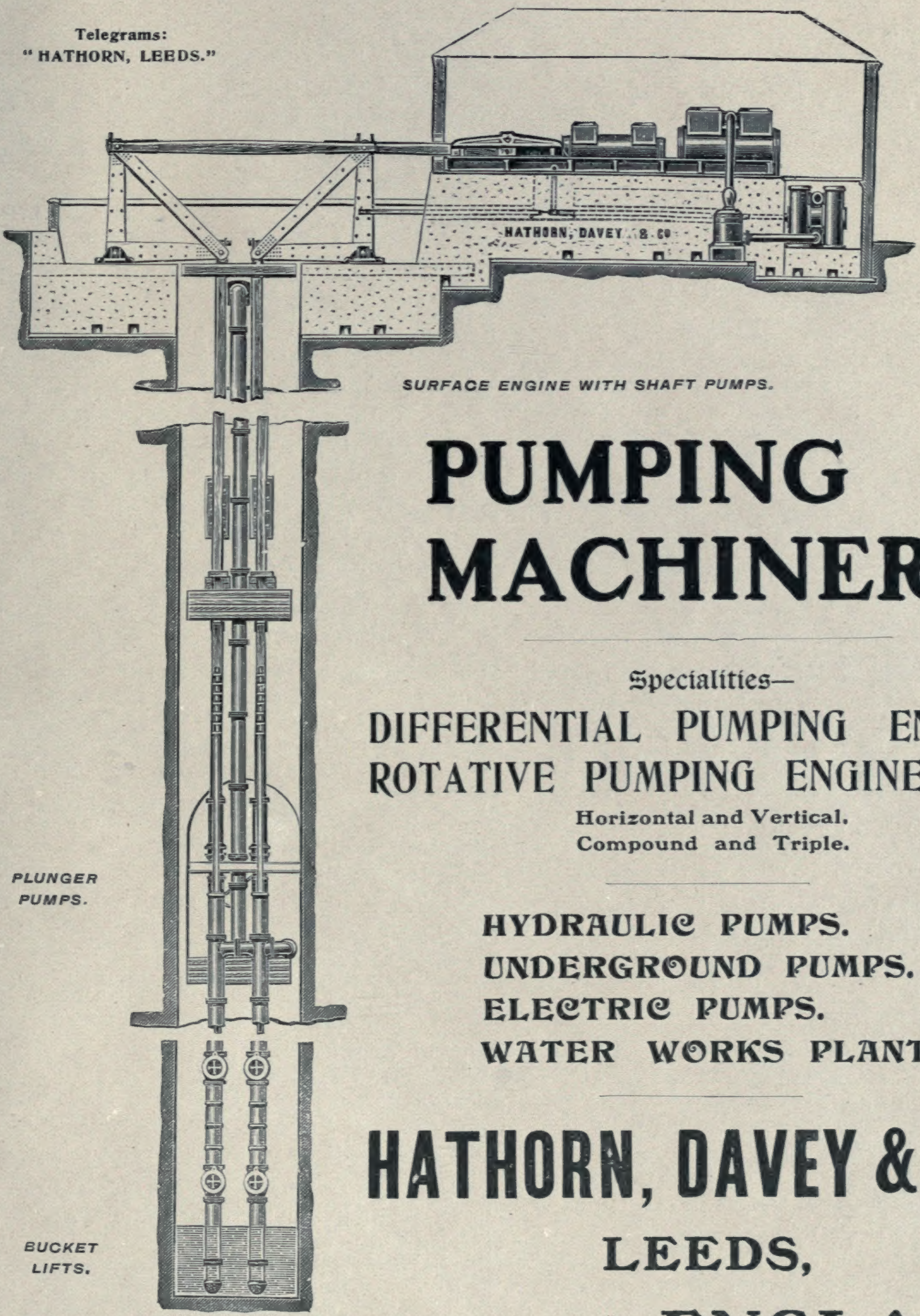

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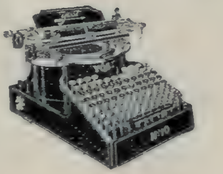

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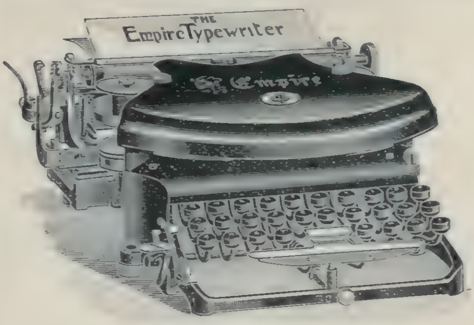

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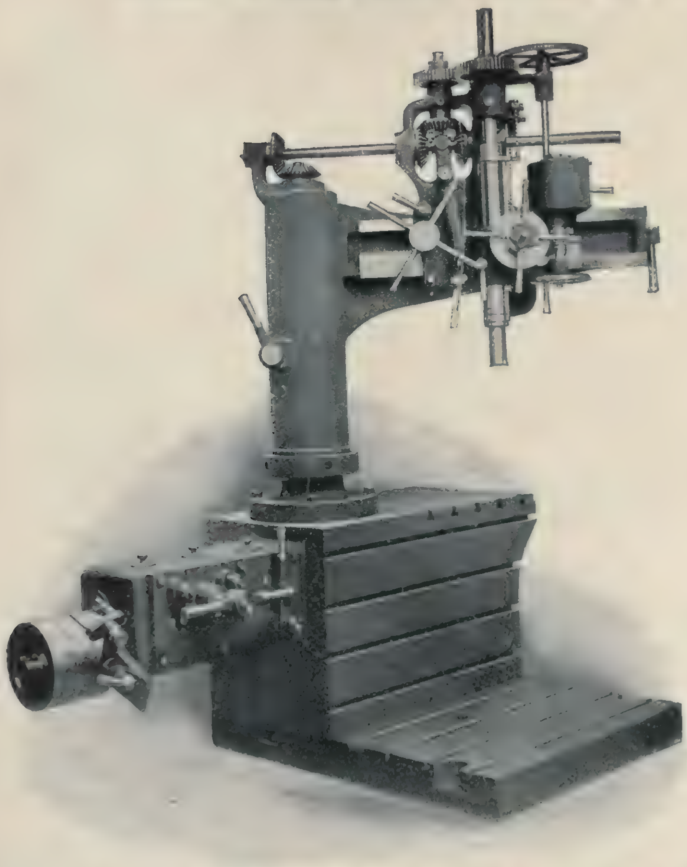

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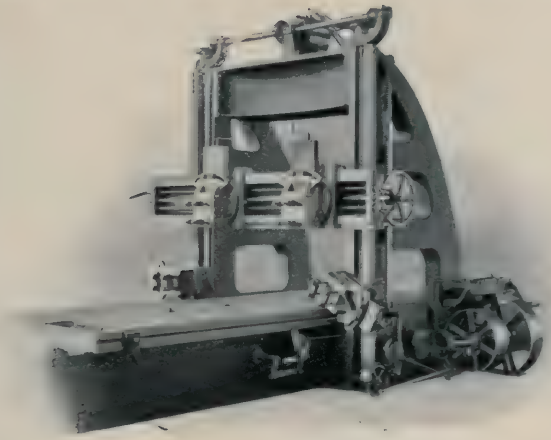

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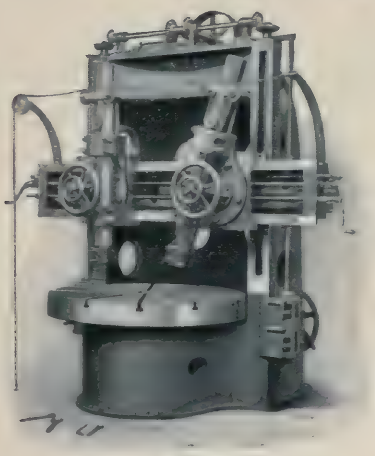

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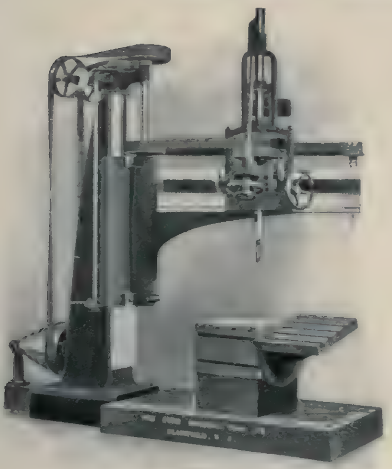

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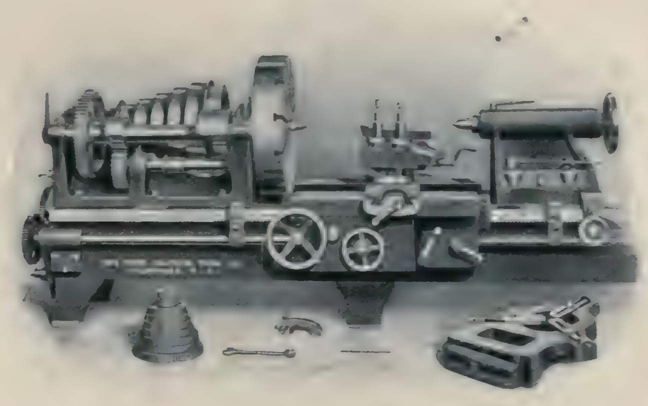

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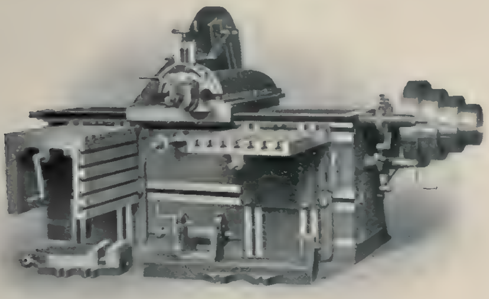

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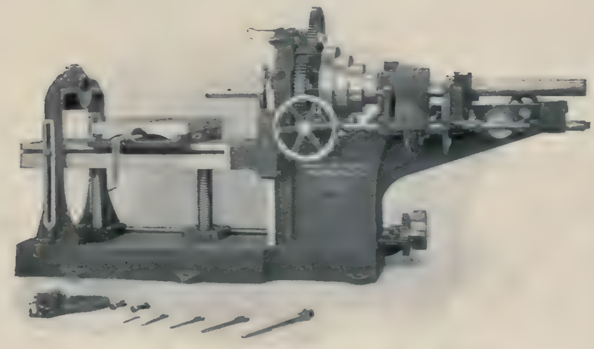

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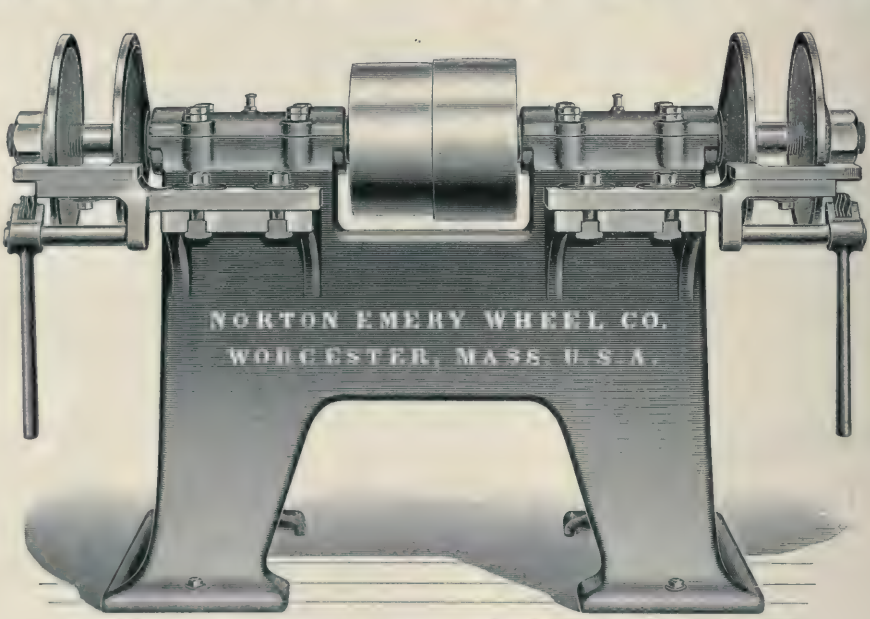

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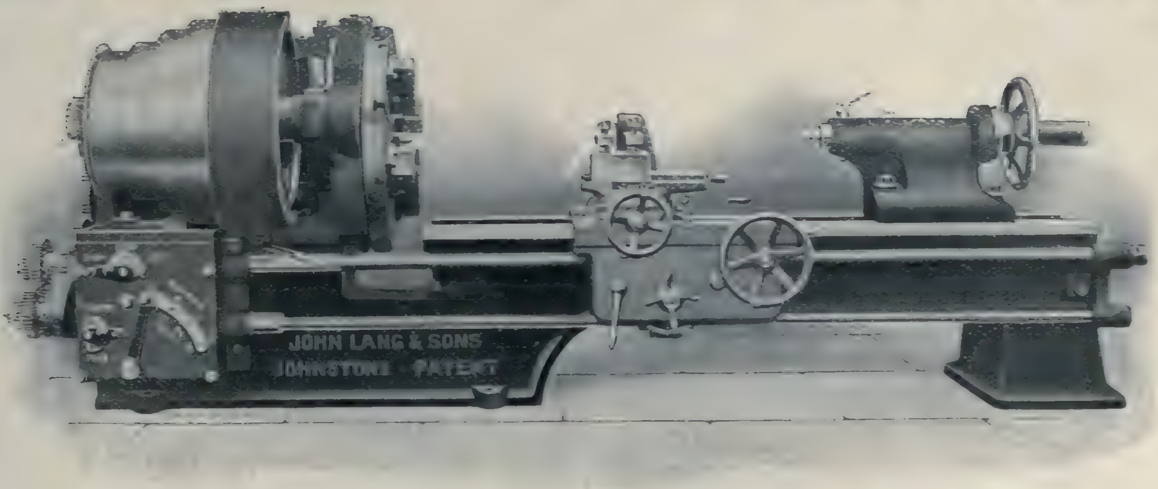

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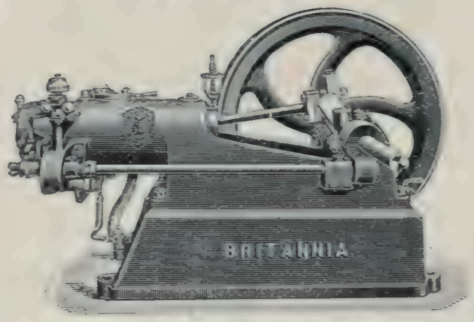

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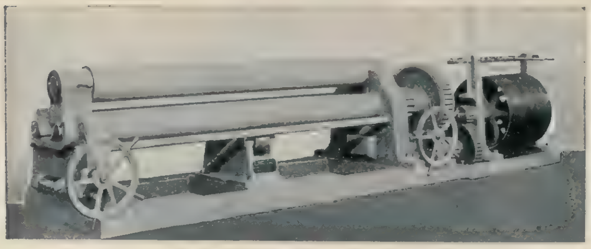

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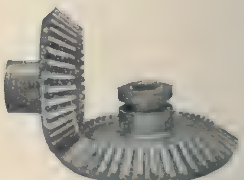

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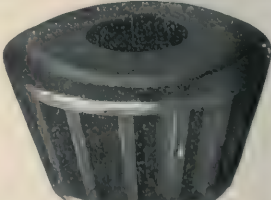

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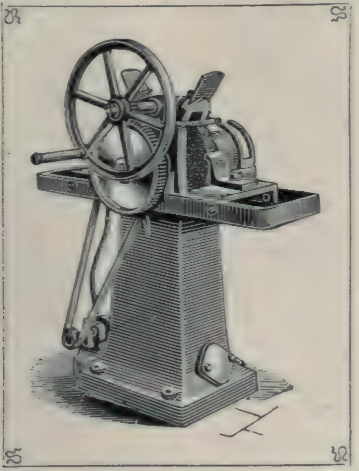

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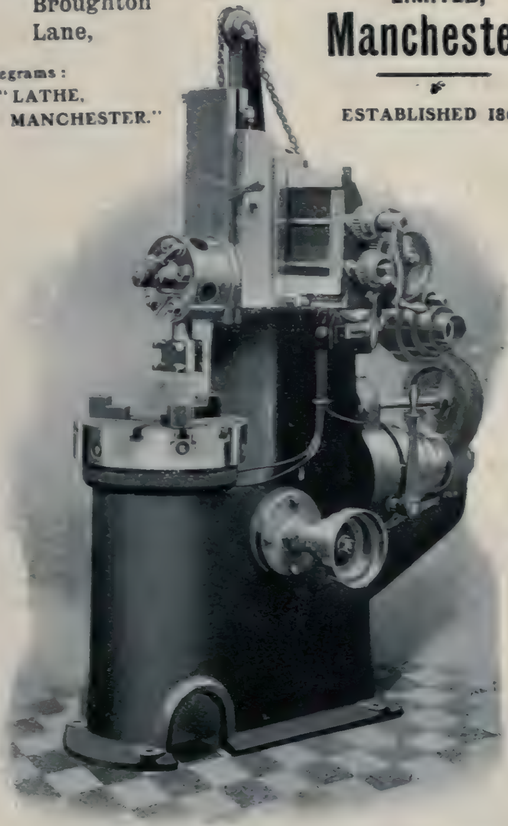

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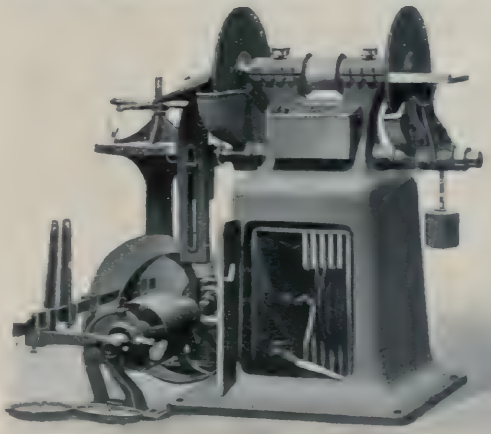

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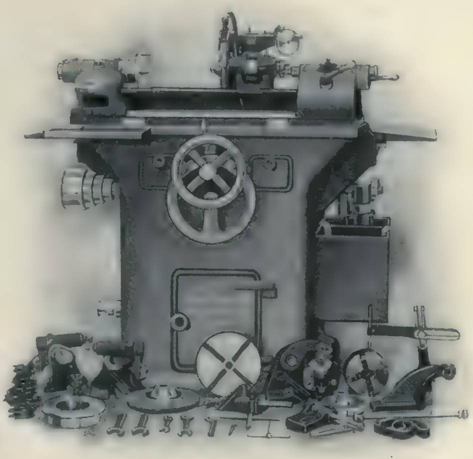

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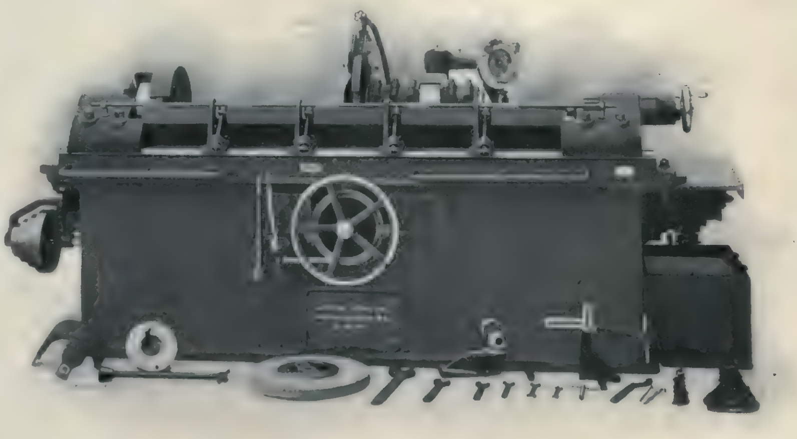

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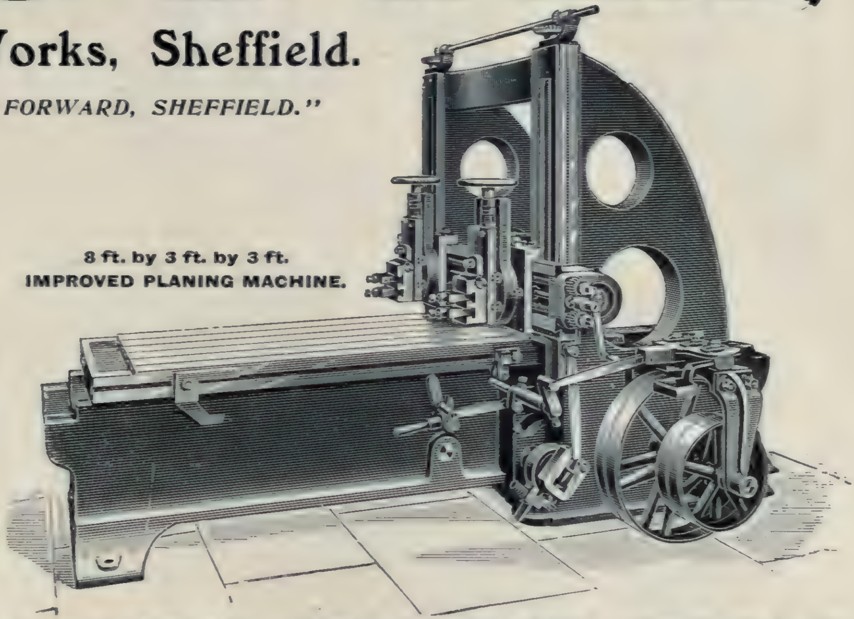

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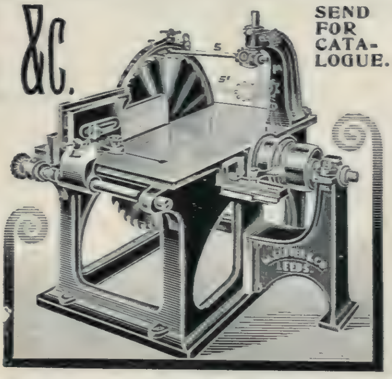

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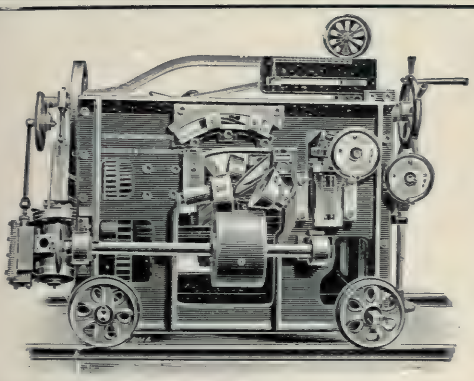

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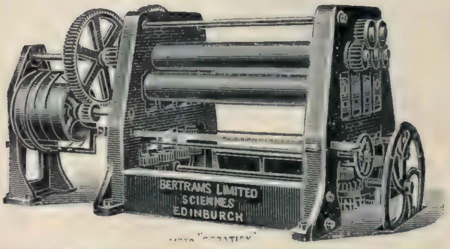

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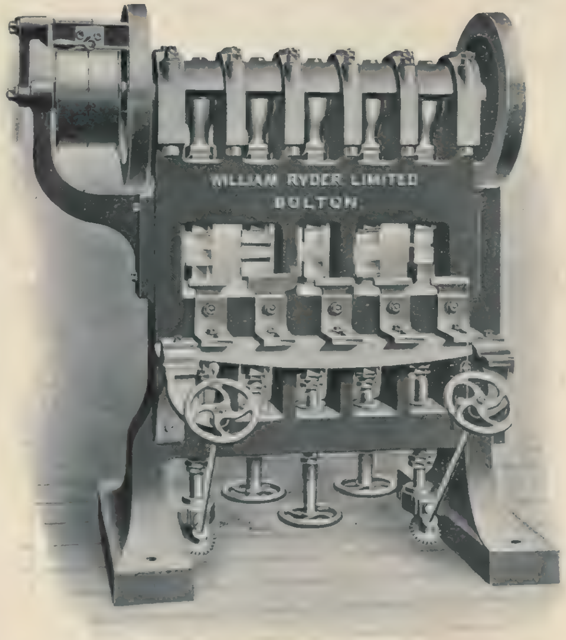

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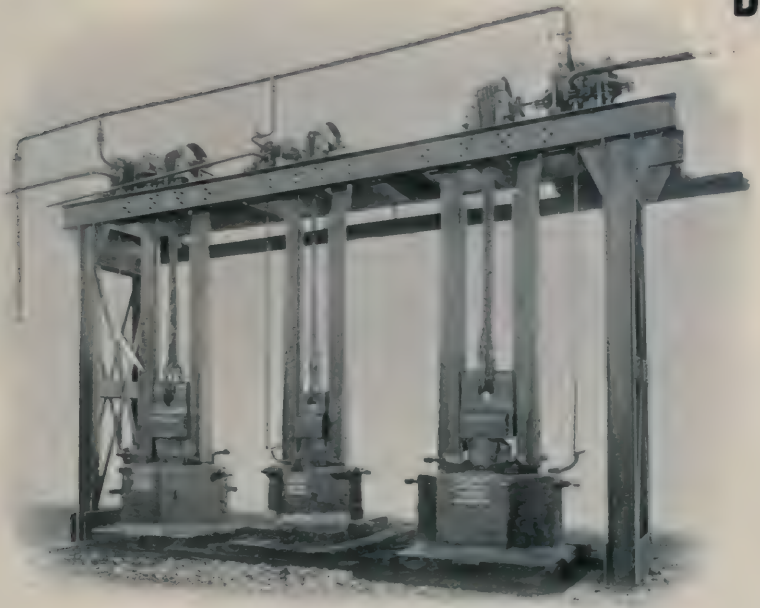

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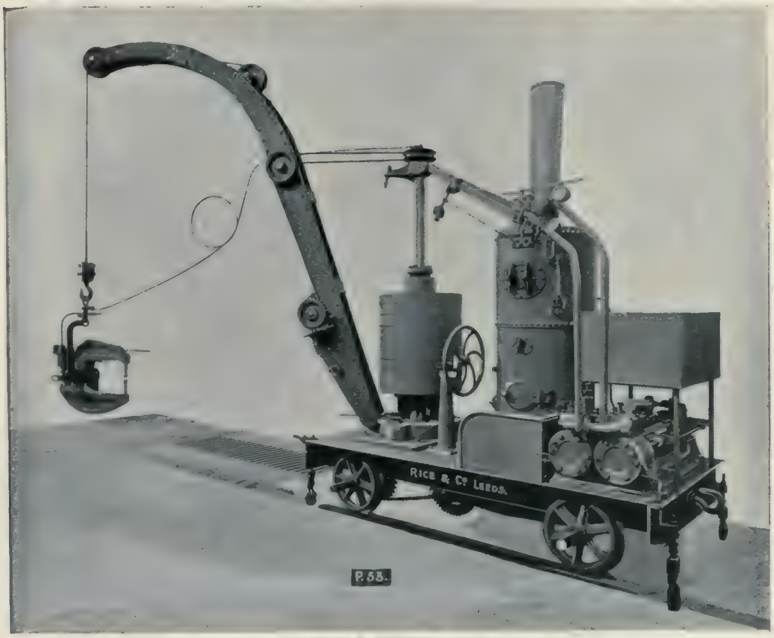

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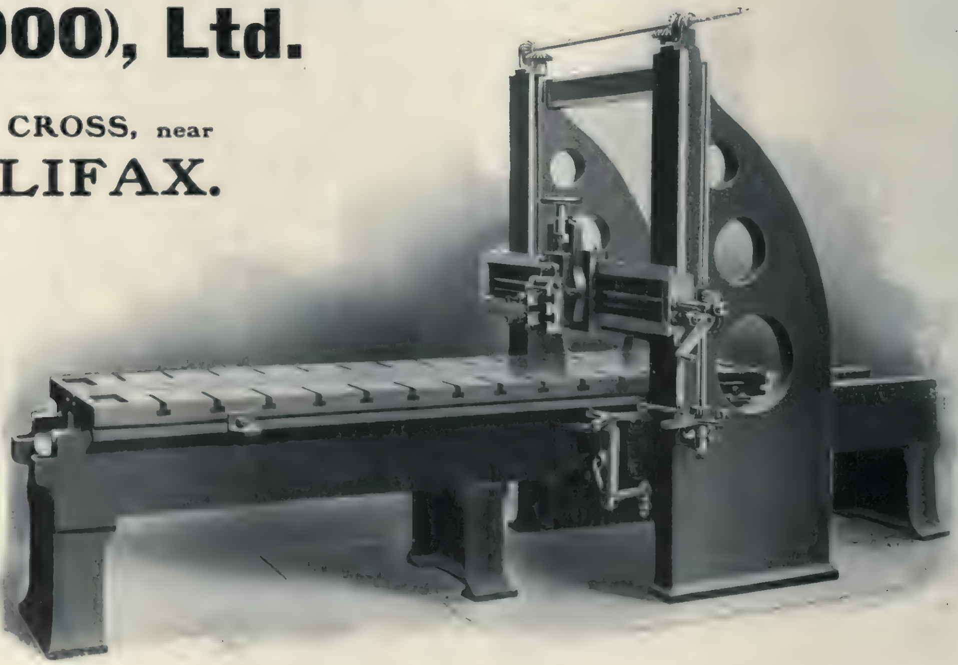

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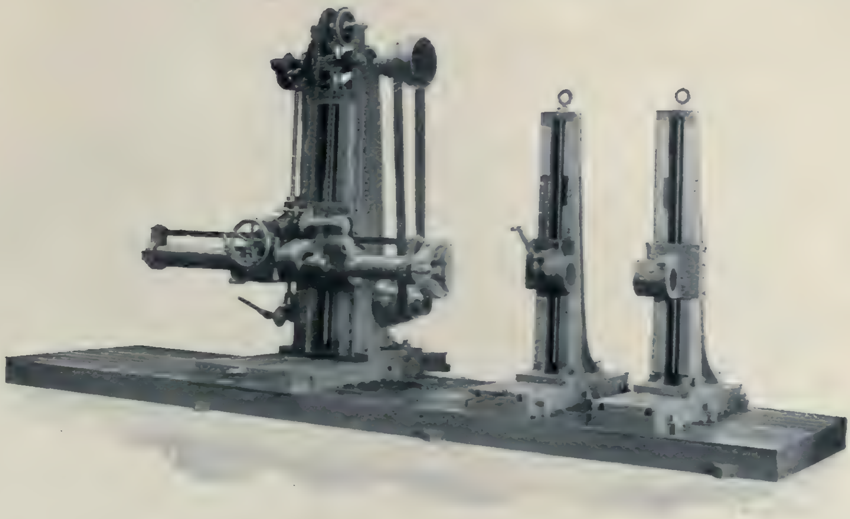

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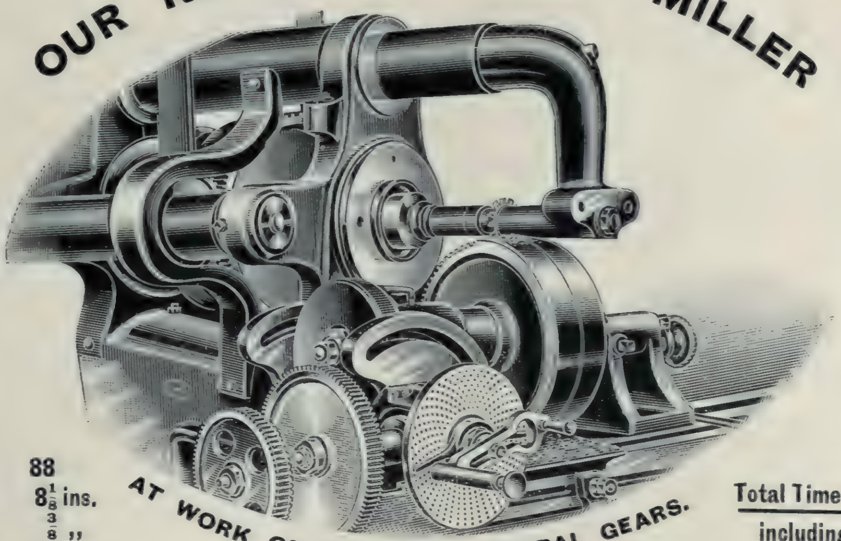

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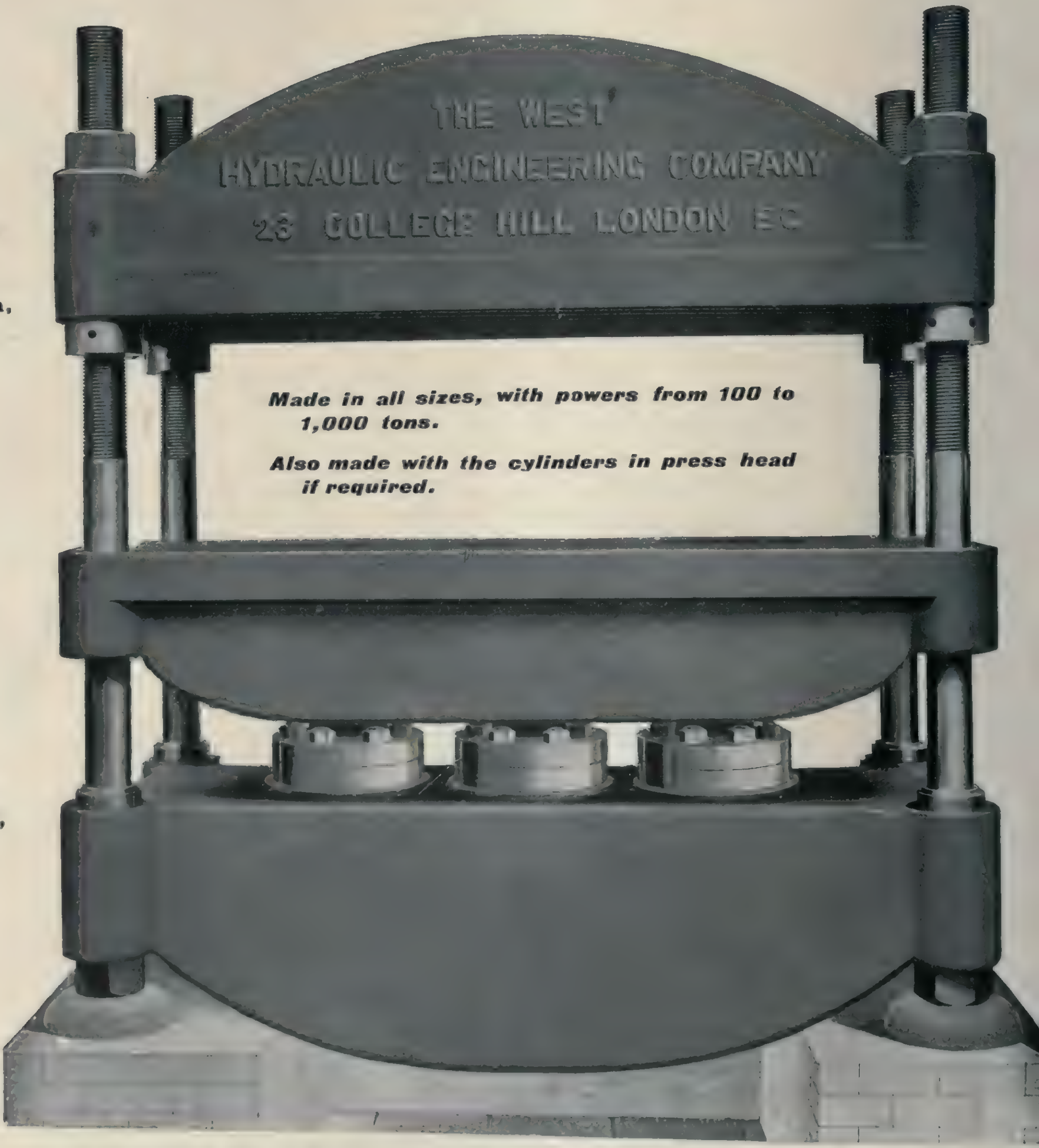

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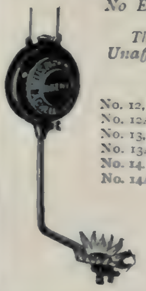

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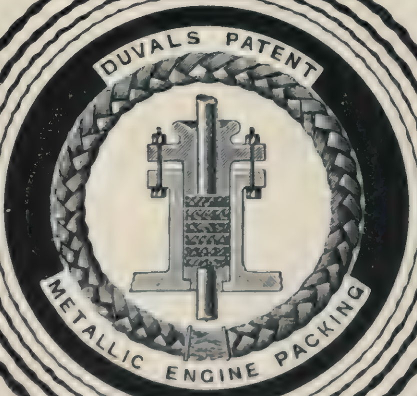

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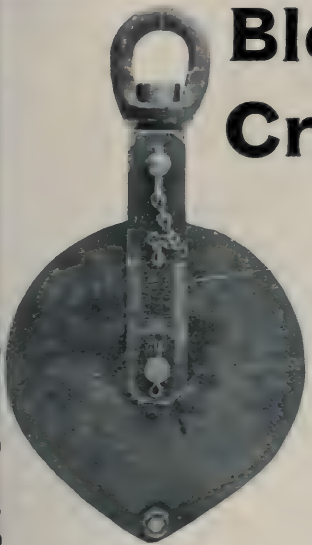

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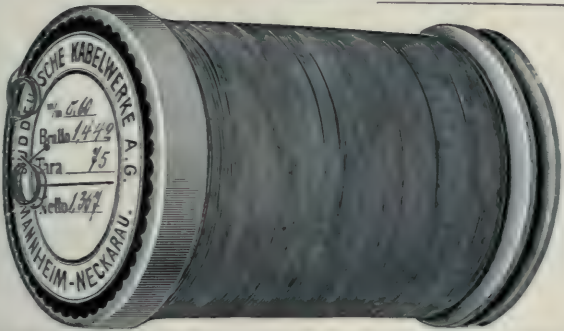

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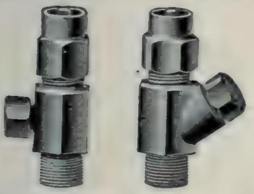

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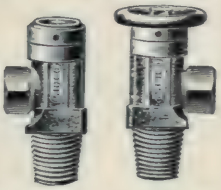

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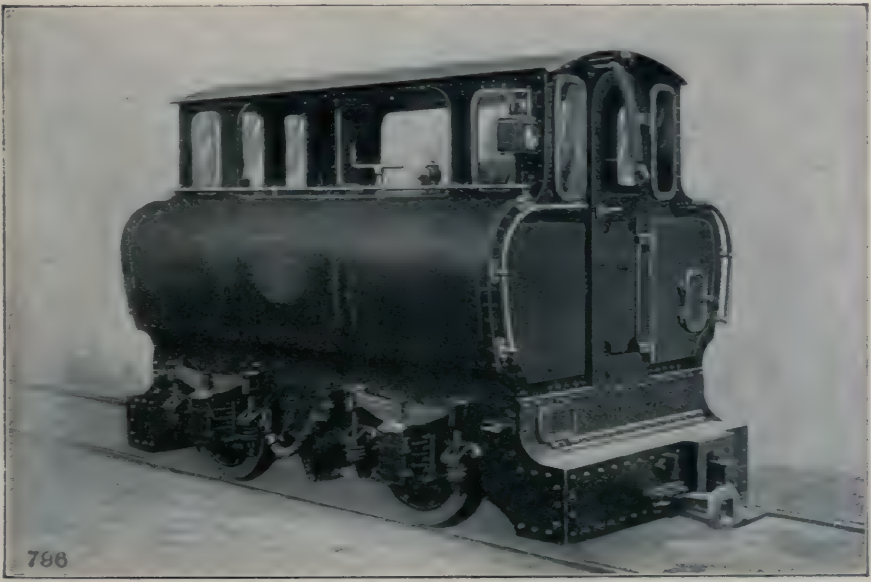

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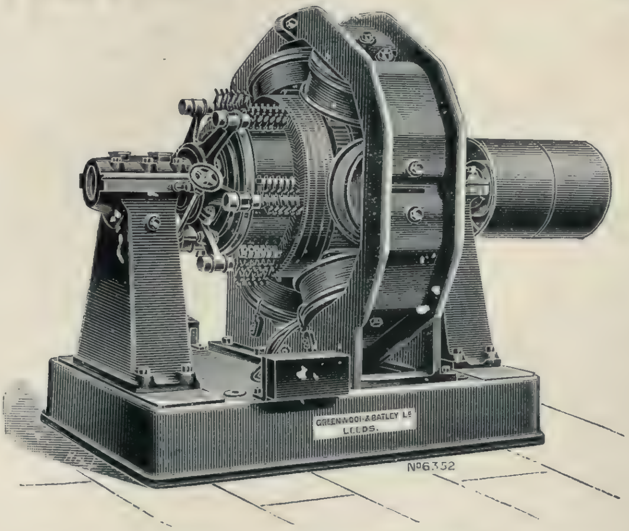

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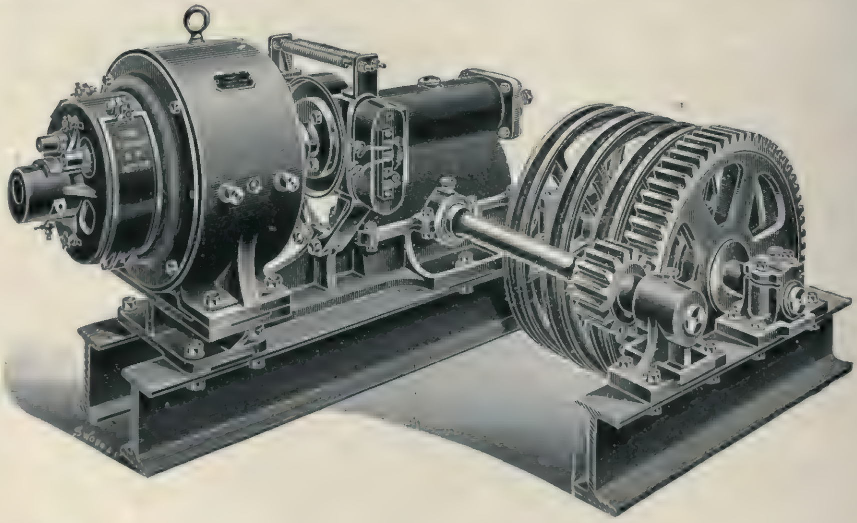

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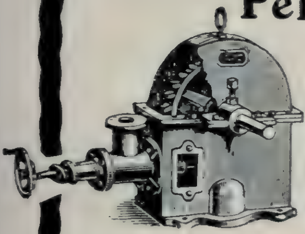

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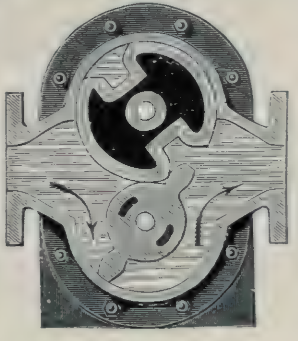

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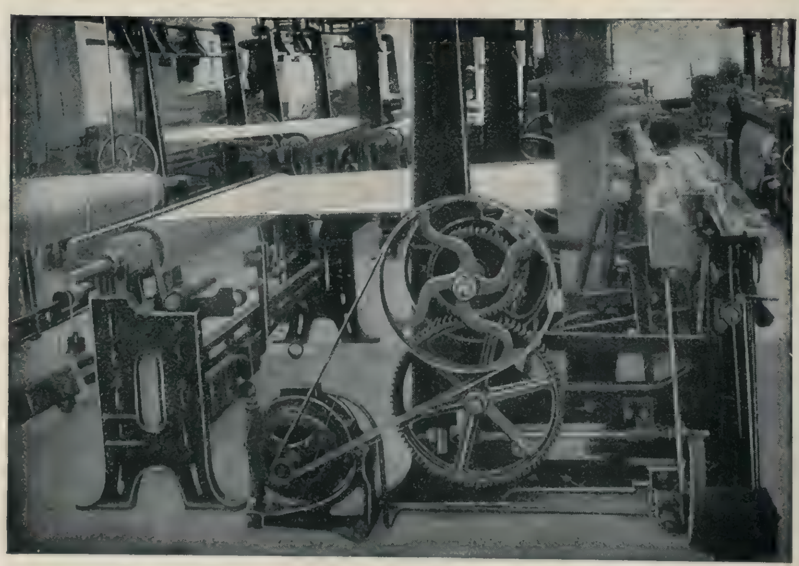

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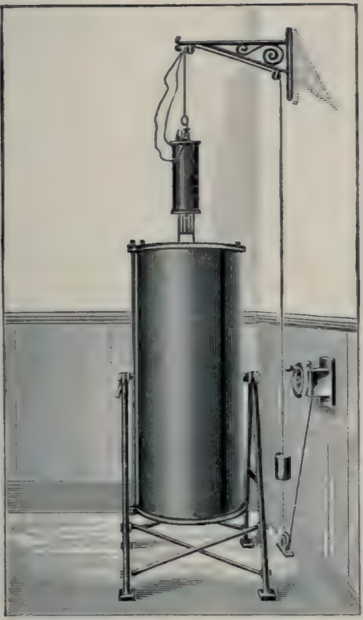

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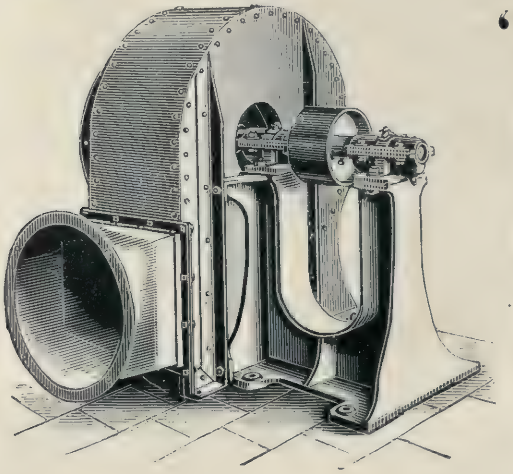

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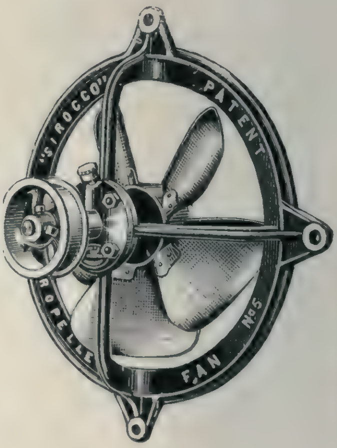

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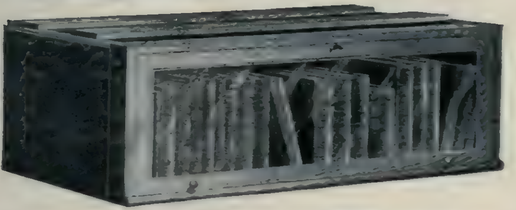

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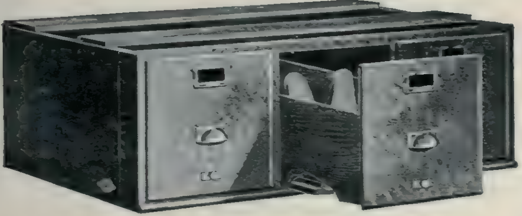

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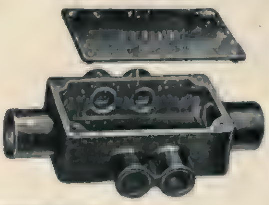

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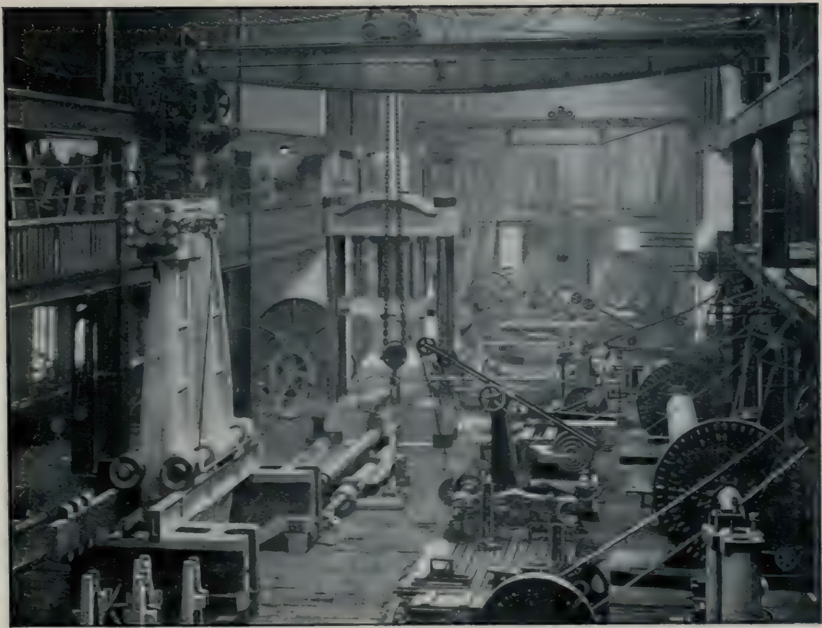

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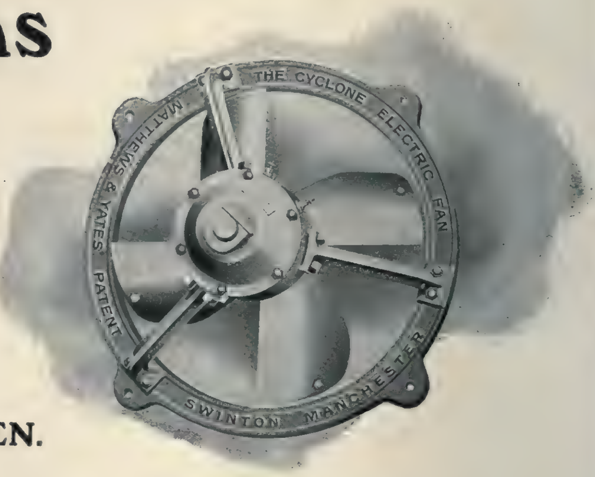

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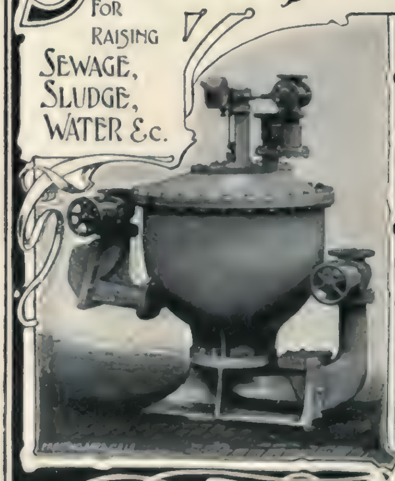

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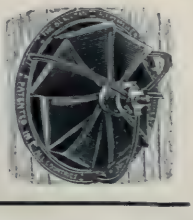

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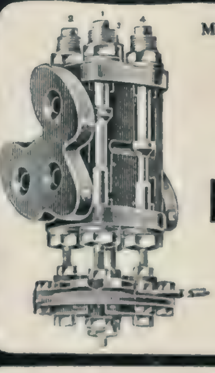

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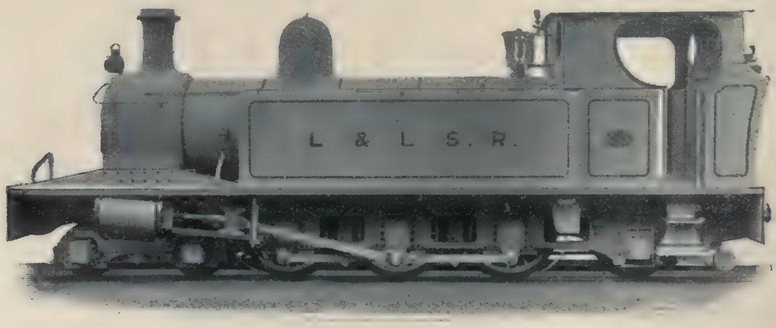

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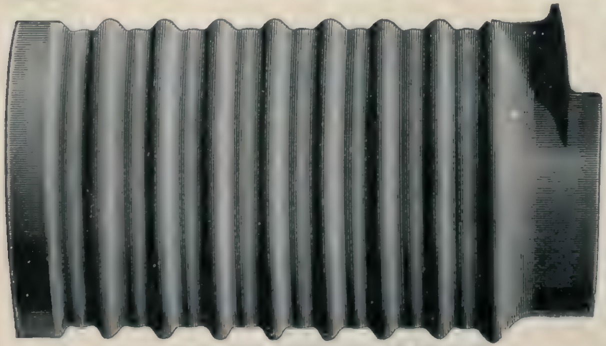

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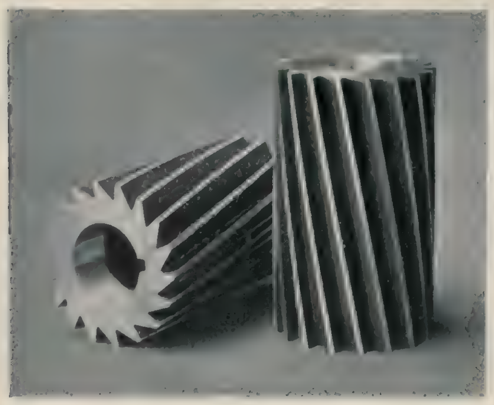

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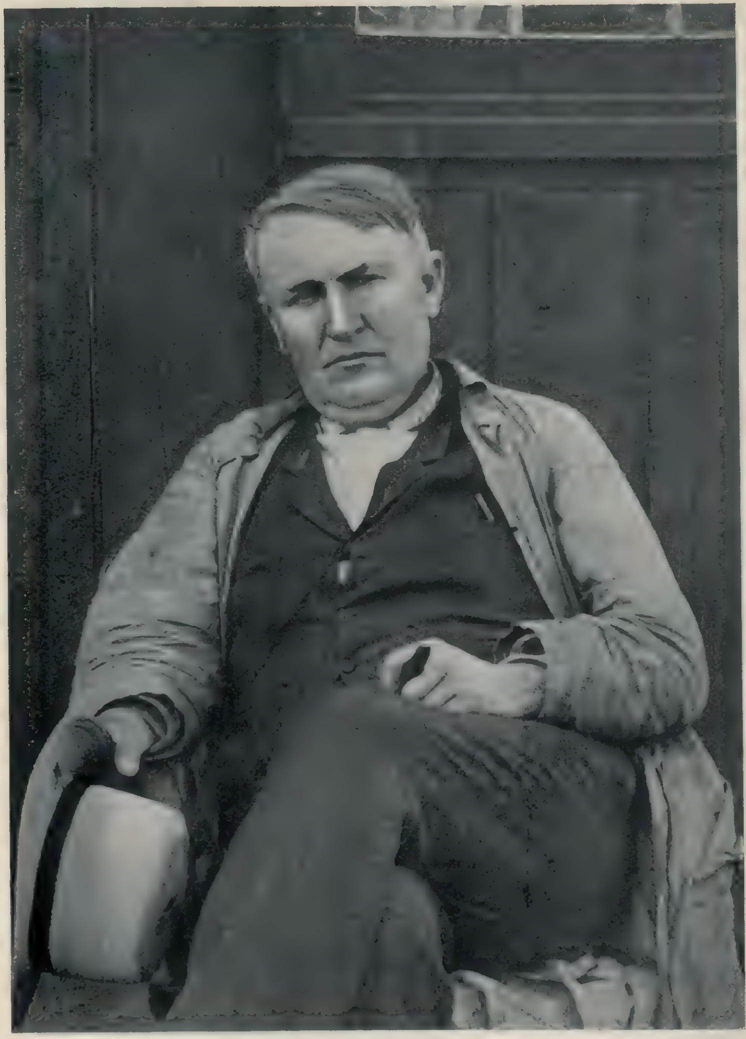

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ARMISTEAD CAY.

A description of the new Midland Railway port which is being rapidly completed at Heysham, near Morecambe. Many of the photographs have been specially taken for this article, and are now reproduced for the first time.—ED.

THE progressiveness of the Midland Railway has rarely been called into question. Unlike some of the other old-established lines it has welcomed improvements and new departures tending to the welfare of passengers before being forced to adopt them by competing lines. Ever since the days of Sir James Allport it has had a reputation for setting the pace, and there is no more striking evidence of the progressive spirit that dictates the policy of the directors to-day than is to be found at Heysham in Morecambe Bay, where the company's new port is now practically an accomplished fact.

Comparatively few people can be aware of the work which has been quietly in progress at Heysham during the last six years; and probably few have realised the imposing scale on which the port has been designed. There is a considerable amount of work still to be done, which will probably require several months, but it is of the nature of equipment only. The project, from an engineering point of view, may be said to be practically complete.

On the occasion of a recent visit, by courtesy of Mr. John Mathieson, general manager of the Midland Railway, the writer had an opportunity of securing special photographs and of making notes on the Heysham scheme. The details of the undertaking were courteously explained by Mr. Baldwin Bent, M.A., M.Inst.C.E., resident engineer.

RATIONALE OF THE SCHEME.

Before discussing engineering details it may be well to devote a brief consideration to the rationale of the scheme, which is the outcome of a determination on the part of the directors to have their own fleet of steamers running between Heysham, the Isle of Man and Ireland. These steamers will be fitted with turbine machinery and in every other respect will meet the modern standard of requirements as regards efficiency and comfort. At the same time, the directors decided to possess their own port and to make such arrangements as would render the running of their steamers independent of the vagaries of the tide, thereby considerably shortening the journey. An important factor connected with this decision is the absorption by the Midland Railway Company of the Belfast and Northern Counties Railway, by an agreement signed in the autumn of 1902.

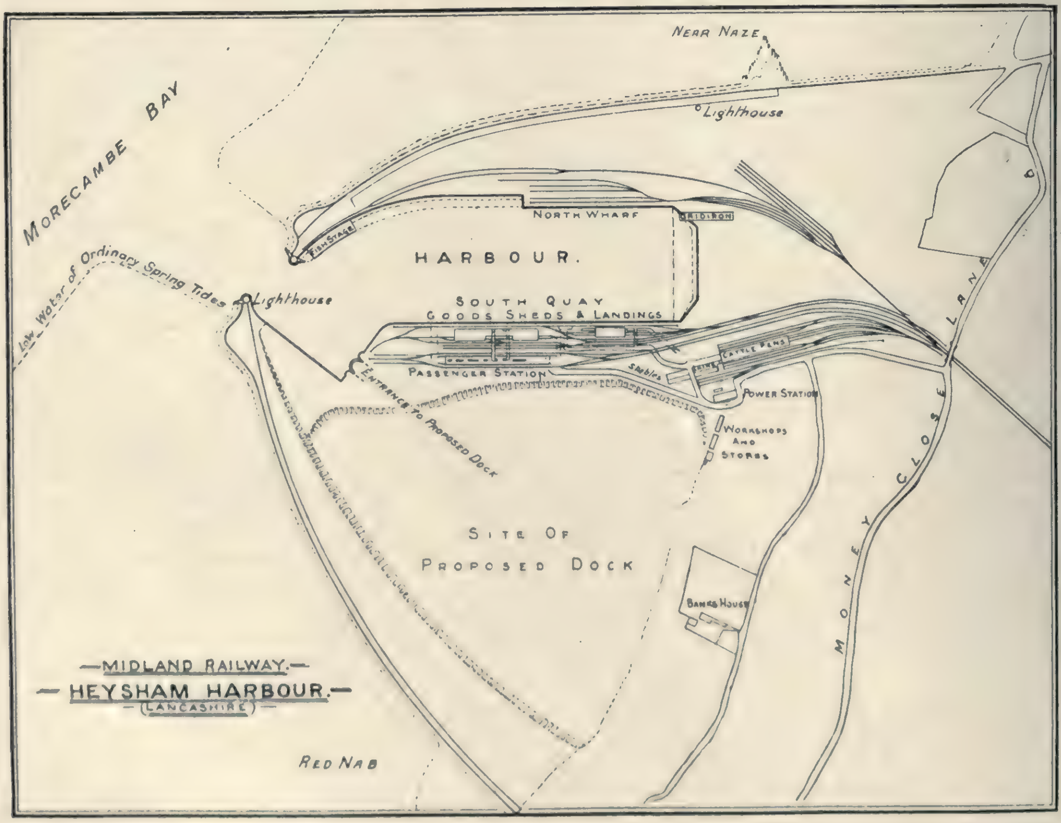
The new steamers will be capable of covering the distance between Heysham and Belfast in 6½ hours. Six journeys to Belfast and back will be made each week, and the same number of journeys to and from Dublin, while twice a week there will be sailings to and from Londonderry. It is anticipated that when the company's arrangements are complete, Belfast will be within 12½ hours of London.

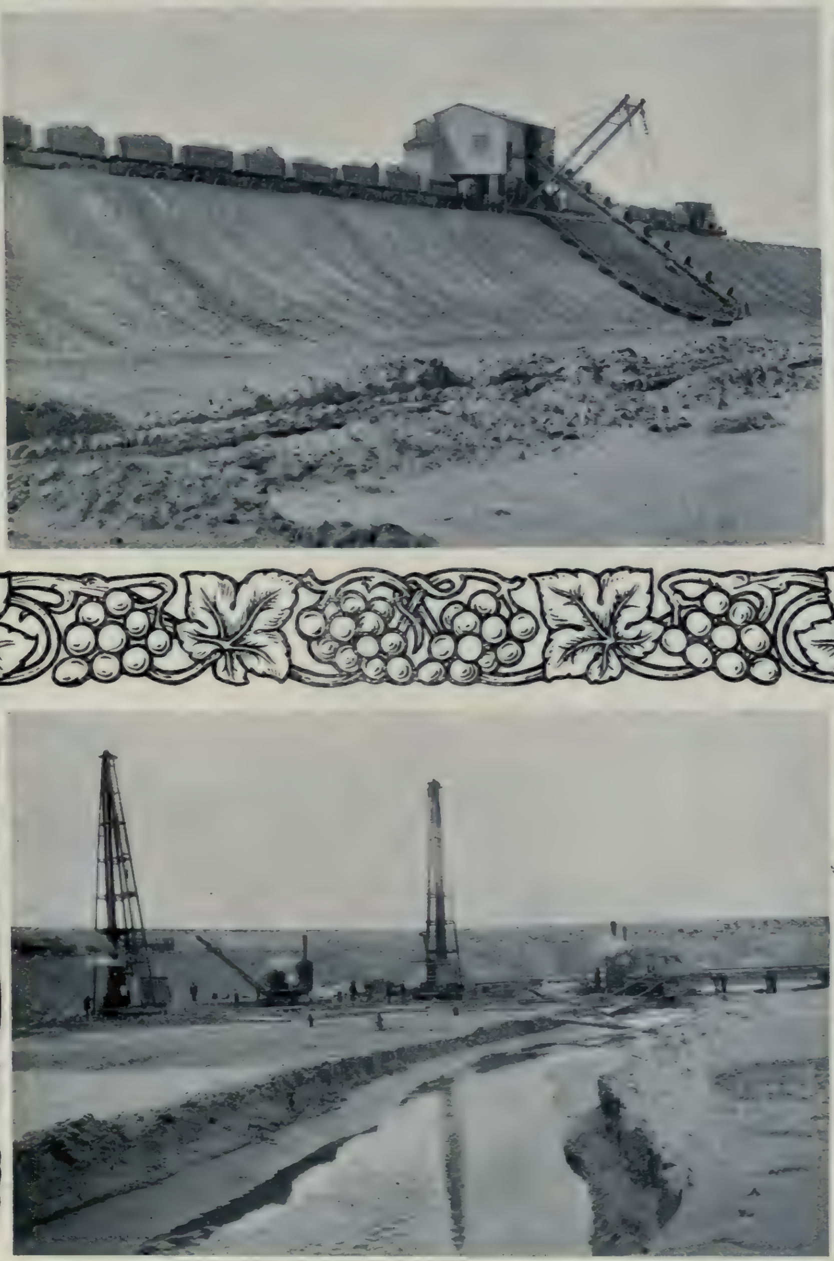
The old stone jetty at Morecambe will no longer be required for shipping purposes, and it is quite possible that it may provide the site for a suitable public improvement. From this pier goods have been shipped for the last fifty years. It was originally built to aid the conveyance of goods from Piel Pier, Barrow, and was subsequently used in the Belfast service for goods and passengers until the transfer of the latter service to Piel Pier. The Londonderry service was next undertaken, and there is also a Dublin service for goods and passengers, the latter having been established sixteen or seventeen years.

THE HEYSHAM SITE.

The site of the new dock offers no features of special geological interest. The underlying rock is of red sandstone which dips towards the sea and is covered with sand to a depth of nearly 30 ft., while underlying the sand in places are beds of stiff boulder clay. In several respects, however, the site is unique. The harbour opens direct into what is known as Heysham Lake—a broad and deep water channel affording direct access to the Irish Sea and thus offering a strong contrast to the Fleetwood Channel, the difficulties of which are well known. Steamers leaving the harbour will only have to negotiate the short channel 900 feet long, from the Roundheads into Heysham Lake, when they can proceed full steam ahead.

Another circumstance favourable to the site is its proximity to the great manufacturing centres of the north. Visitors to Heysham cannot fail to be impressed also with the exceptional opportunity which exists for expansion





THE UPPER PHOTO SHOWS THE LÜBECKER EXCAVATOR AT WORK, TAKING OFF 18 FOOT CUT IN SAND. THE LOWER VIEW ILLUSTRATES PILE DRIVING.—NO. 1 ROUNDHEAD.

A COMPREHENSIVE VIEW OF THE WORKS

when this becomes necessary. It is interesting to note that the four or five hundred acres of pasture land adjoining the docks and owned by the Midland Railway Company will, in the meantime, be turned to good account. Even cattle feel the fatigue of a sea voyage, and there is a consequent deterioration when they reach the market. This will be avoided in the case of cattle shipped to Heysham, by turning them out to grass temporarily on the company's broad acres. Thanks to the enterprise of the Midland Company Heysham bids fair to become a place of considerable importance, and one cannot help thinking that a good deal of the surrounding pasture land will very soon be turned into streets.

Already the district has undergone a remarkable metamorphosis. A low range of cliffs has entirely disappeared. A large slice has been reclaimed from the sea. A huge stretch of made-up ground has been enclosed, and where the sea once held undisputed sway we have an artificial promontory, the extremity forming the entrance to the new harbour.

As will be seen from the accompanying plan the engineers made provision for the future, as well as for the immediate needs of the company, only a comparatively small part of the

EXCAVATION OF HARBOUR BOTTOM, FEBRUARY, 1901.

—SHOWING FINISHING TOUCHES TO SOUTH ROUNDHEAD, AUGUST 1903.
Water was let into the basin on September 2nd following.

promontory being utilised for the present scheme, *i.e.*, that appropriated for the tidal basin, passenger stations, goods depôt, sidings, power house, workshops, etc. The vast low-lying area, shown on the left of the plan, is held in reserve for future wet docks, graving docks, timber ponds, etc.

GENERAL OUTLINE OF THE SCHEME.

The breakwaters at their junction with the coast at Red Nab on the south, and Near Naze on the north, are about a mile and a half apart, while a distance of 2½ miles separates the two extreme shore ends of the embankments. They gradually converge until the Roundheads at

THE NORTH WHARF IN FEBRUARY, 1901, WITH INCLINED WAY IN FOREGROUND USED FOR TAKING OUT EXCAVATED MATERIAL.

MODEL SHOWING LANDING STAGE CONSTRUCTION.

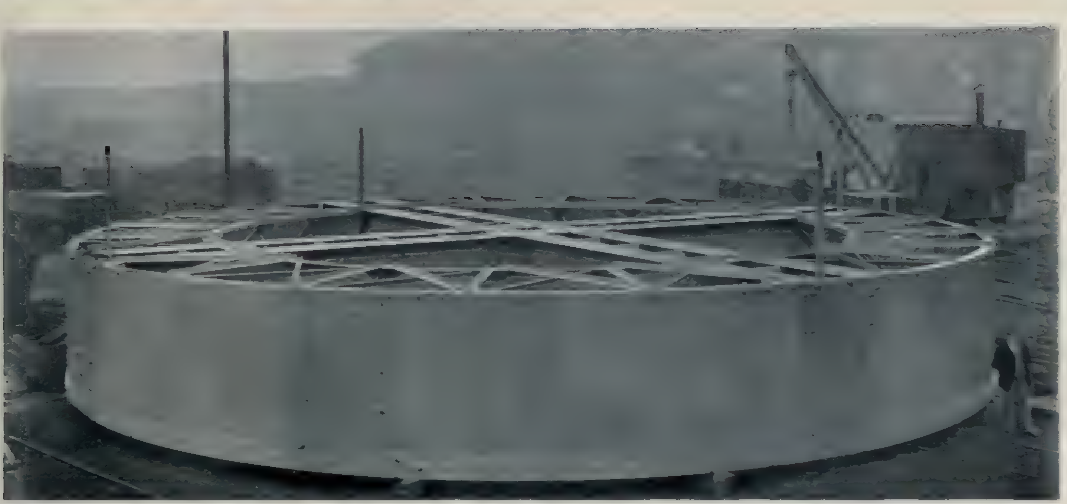
the mouth of the harbour are only 300 ft. apart, and enclose about 140 acres. The whole estate, including the grazing land above mentioned, comprises about 500 acres. The tidal basin forms a rough parallelogram 2,400 ft. in length by 700 ft. broad. The south quay is immediately adjacent to the railway passenger station, goods sheds and cattle lairs.

The rise and fall of the tide here is considerable, varying between 24 ft. and 27 ft. The harbour has 17 ft. at low water and it is intended to provide for sailings at any state of the tide; a substantial three-decked landing-stage has been carried from one end to the other. Along this and the north quay there is sufficient accommodation for a large fleet, while just inside the harbour, near the end of the northern breakwater, a fish stage has been constructed which is, doubtless, destined to bring about very important developments in the Morecambe Bay fisheries.

Adjoining the quay on both sides of the harbour, a network of sidings has been constructed, and, at the time of our visit, no less than eight miles had been laid down. The entrance to the proposed wet dock has been finished off with a strong dam of brickwork, so that it will be possible to conduct future operations in the dry. Incidentally, it may be noted that when this wet dock is taken in hand it will involve far less difficulty than the adjoining basin.

On the north breakwater is an Anemometer Tower, in which are recorded the direction and pressure of the wind, temperature and barometer readings. The data already accumulated in the office of the resident engineer is being carefully tabulated and has already proved of considerable use. Not far from this tower a tall leading light will be built, which will be sighted by mariners, in conjunction with a low lighthouse and signalling station to be constructed at the extremity of the south breakwater. The lighthouse work is being carried out by Messrs. Chance Bros. and Co., who lately undertook the Beachy Head and Lizard Lights. The latest addition to the tidal basin is a gridiron for the repair of vessels. The site of this, as will be seen on reference to the plan, is at the end of the basin.

LANDING STAGE IN COURSE OF ERECTION.



ONE OF THE SHOES FOR ROUNDHEAD MONOLITHS.

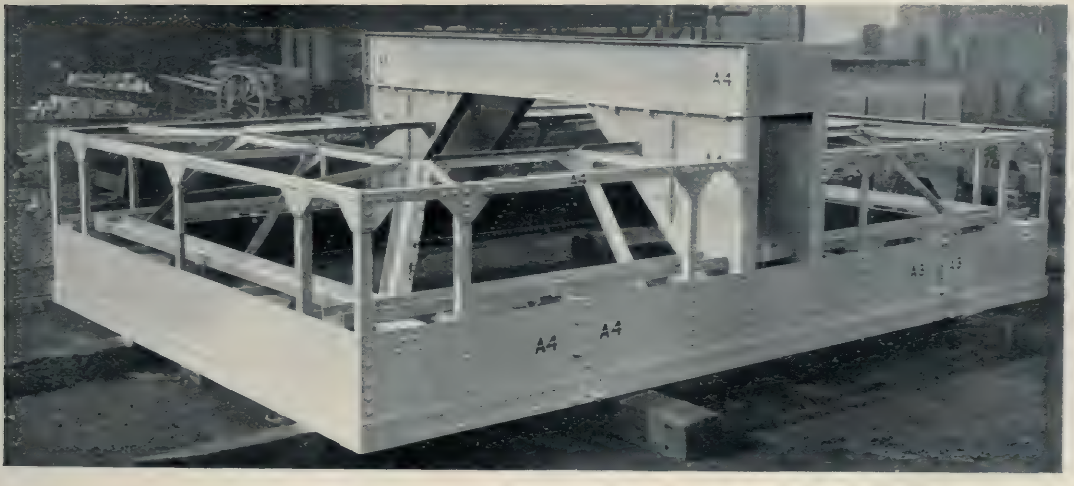
PROGRESS OF THE CONTRACT.

The work commenced in 1897 with the formation of a thin bank corresponding with the present contour of the breakwaters. This was composed of rubble from the cliffs, the outer part being covered with rough blocks of sandstone. The banks were closed in June, 1899, a solid dam being thrown across the space now occupied by the entrance to the harbour.

A sluice built in the centre was found to be of great service, not only in the early stage of the works, but also when the time arrived for water to be let into the dock. It was opened daily at low tide, thus allowing much of the water inside to be cleared by gravitation, thereby reducing considerably the work of the pumps.

The excavation of the harbour was carried on simultaneously with the construction of the quay walls. It involved the removal of three and a-half million cubic yards of earth and sand, and proceeded at the rate of something like seventy thousand cubic yards per month.

The material excavated by the steam navvies was drawn to the top of the banks up an incline by a wire rope, as shown in the accompanying illustration. The lion's share of the



A RECTANGULAR SHOE.

A TOUR ROUND THE HARBOUR, MARCH 8TH, 1904—PANORAMIC VIEW
Roundhead, fish-stage, and north wharf.

work, however, was done by a German steam navvy made by the Lübecker Maschinenbau Gesellschaft and built on the principle of a bucket chain dredger, but with the travel of the buckets reversed. The arrangement will readily be comprehended from the illustration, on page 293. This appliance loaded up the ballast wagons at the rate of six hundred in a ten hours' working day.

In November, 1902, one thousand navvies were engaged on the work, which also gave employment to a varied collection of locomotives, steam excavators and cranes. The works also involved a complete workshop organisation and concrete-making plant, but the latter, at the time of our visit, had disappeared, its work having been accomplished. At one time some seventy boilers were employed for various purposes and fourteen miles of temporary track were in use.

Continuous progress was made with the quay building and excavation until, in September, 1903, it was possible to admit the sea, the harbour being to all intents and purposes, completed. In this operation the sluice in the dam played an important part, as it assisted the engineers in training the water in such a way that a great deal of sand was prevented from entering the harbour. The temporary dam is being removed by hand to low-water level, while last July three English and one Dutch sand pump dredger started clearing the channel between the dock entrance and Heysham Lake, and bucket dredgers with the necessary hoppers are daily expected to complete the removal of the remainder of the dam. Only a small part of the dam now remains visible at low water. On February 16th last, enough had been removed to admit of the sand pump steamers coming inside the harbour at high water.

THE BREAKWATERS.

The breakwaters are strongly faced with blocks of sandstone from Messrs. Whittaker's quarries at Horsforth and from Barrow. The southern arm is somewhat longer than the other in order to afford vessels entering the harbour protection from the heavy south-western gales which are sometimes experienced in the bay. As an instance of the terrible force of these gales one might point to the West End Pier at Morecambe, a large portion of which has been entirely carried away by the sea, leaving a yawning gap in the centre.*

It will be noticed from the plan that the breakwaters gradually taper off in the direction of the Roundheads at the entrance of the harbour. The comparatively narrow ends have also to bear an additional pressure from the sea, and in completing the northern arm it was found desirable to use sheet piling and to stiffen the inner slope with rock rubble, while

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* This was done by the great storm in February, 1903, when a train was blown over on the Leven's Viaduct 11 miles north of Heysham, on the Furness Railway.

—FROM THE SOUTH ROUNDHEAD, LOOKING SHOREWARDS.

In the middle distance is the dam which closes entrance to proposed dock. To the left is the south quay, with adjacent goods sheds and passenger station.

A NEARER VIEW OF THE DAM AND BUILDINGS.

GOODS SHEDS AND PASSENGER STATION.

for the next thousand feet seaward a trench was cut and a toe formed for the inner-slope of the embankment by building in a concrete wall.

The most interesting part of the work, however, was in connection with the foundations of the Roundheads and the adjoining walls. In order to ensure the stability of these, the engineers have employed an ingenio system of monoliths. For this purpo specially constructed steel shoes, with cutti edges, were made by Messrs. Handyside a Co., Ltd., of Derby, each being used as t base of a brick or concrete pier. Vertical shaf left in these piers rendered it possible f excavators to proceed with their work fro

ANOTHER VIEW, SHOWING THE PASSENGER STATION (ON THE RIGHT) IN PROCESS OF COMPLETION—TO THE LEFT, GOODS SHEDS AND CONNECTING BRIDGE.

the interior while the sinking of the shoe consequent upon the weight of the superimposed brickwork was aided by its cutting edge. In this way the piers gradually sank until a solid foundation was reached, and, of course, special precautions were taken to ensure that they sank evenly. Steel shoes, built of light plates, were chosen in preference to cast-iron in consequence of the tremendous pressure which these structures have to bear.

Our illustrations show both the square shoes and those of circular form which were used for the Roundheads. The latter were at the time probably the largest structures of the kind extant. Two of them are 55 ft. in diameter, weigh 6,000 tons each, and are each built up of something like one million bricks. They extend 72 ft. below sand level. On reference to the plan it will be noted that the outer ends of the breakwaters are further protected by widening the embankments.

THE TIDAL BASIN.

The tidal basin offers a clear water space of 36 acres. The total length of quay is about 3,500 ft., apart from the space appropriated for trawlers. A minimum depth of 17 ft. has been insured at ordinary spring tides, while at times, owing to the tidal range mentioned above, the water may be within 6 ft. or 7 ft. of the top of the quays. The quay walls are built of mass concrete topped with Shap granite coping. The south quay measures a third of a mile from end to end, the north wall, also of concrete, being 900 ft. in length. The walls are 53 ft. in height, the foundations going down to the solid rock, while at the outer extremities they have been specially strengthened as indicated above. The timbers used as fenders at the north quay, and also for the construction of the landing stage on the south side, are of Australian karri and are about 40 ft. in length. The landing stages present a somewhat extraordinary perspective as may be judged from the accompanying

A TOUR ROUND THE HARBOUR (*continued*).
This view shows a portion of the landing stage at the South Quay.

VIEW FROM THE SHORE END OF THE HARBOUR, SHOWING NORTH QUAY.

illustration. They are connected with the quay above by steps and subways, the walls of the latter being faced with glazed brick.

On leaving the steamers passengers will enter an electric lift which will carry them to a bridge over the line direct to the passenger station, which will be reached by a second lift, so that the interval between steamer and train will be reduced to a minimum.

Cattle will be driven up sloping subways direct to their pens. There is ample space for further siding accommodation should this be required.

ELECTRICAL PLANT, ETC.

Electrical power is to be used throughout the docks wherever possible for lighting, cranes, lifts, etc. The accompanying illustration shows

END OF THE RAILWAY SIDINGS ABUTTING ON THE NORTH QUAY.
Beyond is the mouth of the harbour, with fish stage.

POWER HOUSE AND MOND GAS PLANT.

the Power House and Mond Gas installation. The plant includes three gas engines of vertical type, each 250 i.h.p., using Mond gas. Each engine will be direct-coupled to a generator. Each generator will supply continuous current and give an output of 150 kilowatts, normal voltage=460 volts. The storage battery will consist of two sets each of 115 cells. Each cell will have a minimum capacity of 180 amperes for six hours, with a final voltage of 1·85 volts per cell. The battery will be capable of discharging, if required, 300 amperes for three hours. The electrical plant will also include a battery booster of automatic reversible type, arranged to be suitably affected in its action both by the variations in E.M.F. of the cells, according to their state of charge and by the demand for power from the bus bars. The remainder of the plant consists of a power-feeder booster, balancer and lighting booster, two pumps and motors for circulating cooling water round engine cylinders, two air compressors and motors for air necessary to start engines, and a 10-ton overhead crane in engine house.

The whole of the electrical plant and machinery was designed by the Company's Chief Locomotive Engineer, Mr. R. M. Deeley, and was carried out by the British Westinghouse Electric and Manufacturing Company. The Mond gas plant consists of two 6 ft. producers, superheaters, air and gas towers, gas holder, mechanical washer, and scrubbers, blower and circulating pumps, two vertical boilers, coal shoot, bucket elevator, screw conveyor, over-head hopper, coal storage bunkers and automatic fuel weighers.

Other machinery includes two 3-ton capstans and ten of 1-ton capacity, pumps capable of delivering twelve thousand gallons of water per hour to reservoir, two sets of fire pumps, each set consisting of two pairs of pumps driven by motor and each pump delivering 350 gallons per minute or each set delivering 700 gallons per minute and of throwing to a height of 150 ft. through a 1½ in. jet or through four ¾ in. jets to a height of 100 ft.

THE GAS PLANT IN COURSE OF ERECTION.

RAILWAY WORKS.

At the present time passengers *en route* for Morecambe leave the fast Northern expresses at Hellifield, continuing the journey by a local train. The logical outcome of the dock scheme will be a through service of expresses from Leeds. There is also a loop line from Heysham to Morecambe which will prove useful to tourists breaking their journey at this point, and very shortly there will be a motor service between these places.

The directors have decided to use the harbour station for local purposes, and a road has accordingly been put in from Money Close Lane, past power house, to the passenger station, as shown on map. Every effort is being made to complete the station as soon as possible. The illustration on page 300 shows its appearance on March 8th. The commodious goods sheds have already been completed, while the sidings immediately adjacent to the north quay will give the company every facility for making up their trains of pig iron and merchandise. The large goods shed will have four 30-cwt. electric platform cranes of 15 ft. radius and the same number of 5-ton electric wharf cranes of 34 ft. radius. Four cranes comprising two of each of the kind mentioned will be available for the small shed, while at the west end of the goods shed at the quay side will be fixed a 2-ton electric wharf crane of 33 ft. radius. All these cranes were supplied by Messrs. Stothert and Pitt, of Bath, subcontractors to the British Westinghouse Company.

IMPLEMENTS AND MACHINERY.

A great deal of interest centres round the workshops, and the implements and machinery used in the execution of the contract, but these we are compelled to dismiss briefly. A large quantity of the plant, including the concrete mixers, has already been cleared away. It may be mentioned that the locomotives used were made by Messrs. Manning Wardle and Co., Messrs. Hudswell Clarke and Co., Ltd., and the Hunslet Engine Company. Messrs. Ruston and Proctor, and Wilsons, Whittaker, and John H. Wilson and Co. were to a large extent responsible for excavators, derricks and cranes. Other prominent features of the plant included pumping machinery by Messrs. Tangyes.

ENGINEERS AND STAFF.

The engineers of the Heysham Harbour scheme are Mr. J. Allen McDonald, M.Inst.C.E. (chief engineer to the Midland Railway), and Mr. G. N. Aberneathy, M.Inst.C.E., Mr. Baldwin Bent, M.A., M.Inst.C.E., is the resident engineer. The contractors are Messrs. John Price and C. J. Wills, their representative being Mr. Robert Hollowday. To accommodate the workpeople an entirely new settlement, known as Klondyke, has been created.

For many of the illustrations we are indebted to Mr. Baldwin Bent; others were kindly supplied by the contractors. Messrs. Handyside and Co. furnished the illustrations of the steel shoes, and the remainder of the views showing a tour of the harbour were taken by the writer.

THE SOUTH QUAY IN SEPTEMBER, 1903.

ELECTRIC TRAINS PASSING AT CROSSENS.

THE ELECTRIFICATION OF THE LIVERPOOL AND SOUTHPORT LINE.

Being some Account of an Inaugural Trip in which the Editor recently participated and a Description of the Plant.

A SMALL party of specially invited journalists representing the technical press of Great Britain attended on Saturday, March 12th, the first trip of an electrically driven passenger train on the Southport section of the Lancashire and Yorkshire Railway.

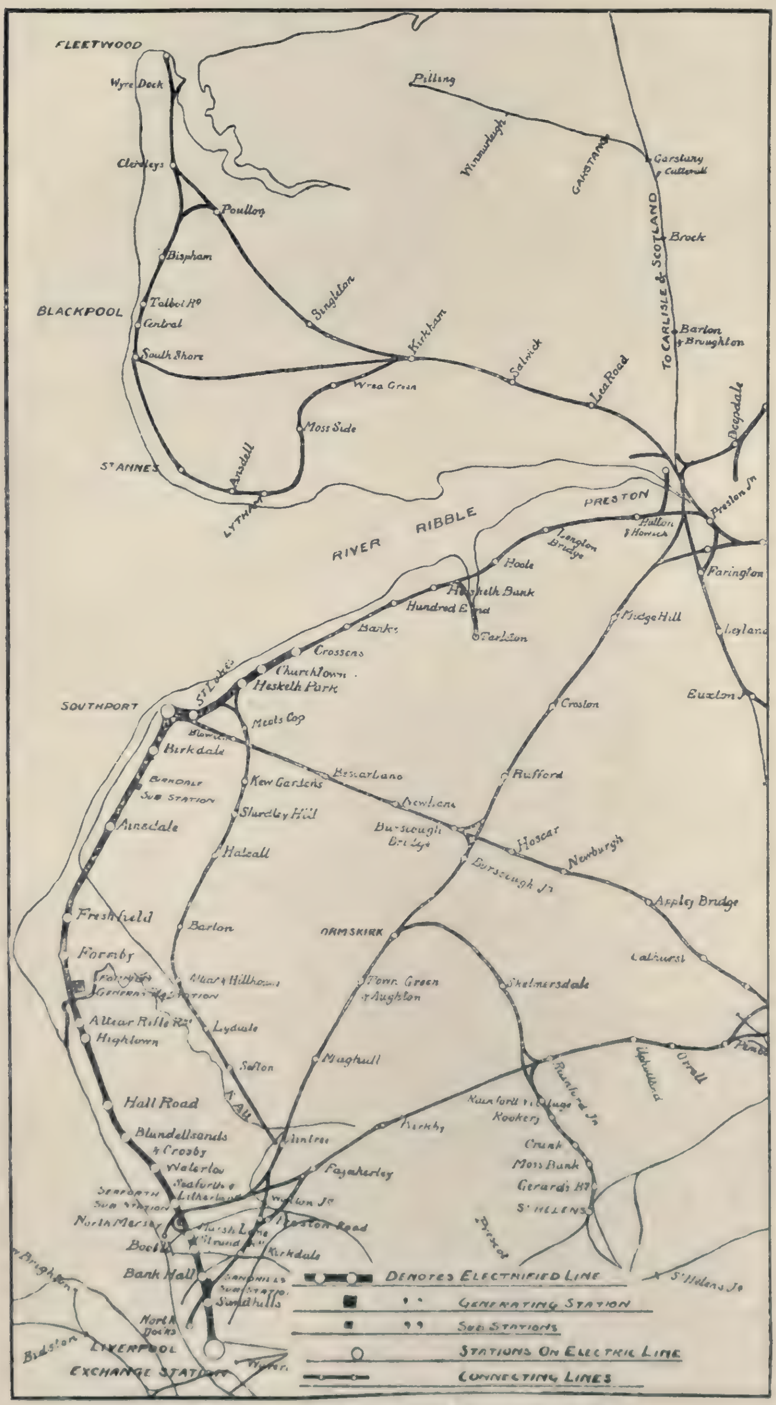
The honour of possessing the first electrified main lines in this country is shared by the Lancashire and Yorkshire and the North-Eastern Railways. Both these lines have now been prepared for electric traction, but prior to the 12th ult., only experimental trains have been run. This journey between Liverpool and Southport may therefore be said to mark a new era in the history of main line railway travel.

At the sound of a horn the train started without a jar. In a moment or two it had attained a speed of thirty miles, and presently was travelling at sixty miles an hour, the vibration being almost imperceptible. The distance from Liverpool to Southport is nearly eighteen and a half miles, and this was accomplished in twenty-four minutes, in spite of the fact that a signal stop of a couple of minutes had to be made on the way.

The scheme generally was originated by Mr. J. A. F. Aspinall, the general manager of the company, who long ago realised the possibilities of great traffic development in the residential districts which lie between Liverpool and Southport, and on the north side of the latter town. The new service, with its greater facilities, will no doubt lead many Liverpool business men to take up their residence on the north side of the city, and particularly in the charming suburbs on the further side of Southport.

The total length of track equipped is practically equivalent to 47 miles of single line. The gradients on the road are slight, and there are but few curves, the steepest gradient being a short length of 1 in 85 near Waterloo, and the sharpest curve one of 7 chains at Southport; with these exceptions, the line is level and straight. There are fourteen intermediate stations, which lie at an average distance of about one mile apart on the southernmost portion of the route, but are more widely separated on the northern portion. The traffic is almost wholly passenger, business people going to and returning from Liverpool in the morning and evening, with a considerable shopping and miscellaneous traffic during the day.

Under steam conditions, there are about thirty-six trains per day in each direction between Liverpool and Southport; a similar number running in each direction between Liverpool and Hall Road, a station some seven miles from Liverpool. The majority of these trains stop at every station, a few expresses being run in the morning and evening for the accommodation of the business men. The running times are at present as follow: Express trains 25 minutes, stopping trains 54 minutes, Hall Road stopping trains 25 minutes. The total train mileage per diem is about 1,900.



MAP OF THE ELECTRIFIED AND CONNECTING LINES.

With electrified conditions the train mileage will be increased to 3,200. The number of trains in each direction between Liverpool and Southport will be increased from 36 to 65, and between Liverpool and Hall Road from 38 to 54. Moreover, the running time from Liverpool to Southport will be decreased from 54 minutes at present to 37 minutes, and from Liverpool to Hall Road from 25 minutes to 17 minutes; the schedule time of the fast trains will remain unaltered, but there will be an express in each direction hourly, instead of only rarely. In addition to this, the express trains will run on to Crossens, giving that suburb a service of 17 trains each way during the day. These arrangements, however, do not represent the ultimate capacity of the line, and if the traffic in the course of a year or two were to demand it, there would be no difficulty in running an even more frequent service. It is intended to shorten the stops at the intermediate stations, and as this will make fresh arrangements necessary to deal with heavy luggage and parcels, a special baggage car has been built to deal only with this service. This car will make numerous trips between Liverpool and Southport, and will immensely increase the ease and rapidity with which parcels can be delivered in the residential districts between Liverpool and Southport.

GENERAL OUTLINE OF SYSTEM.

The portion of the line which has been electrified is shown on the map, and it is obvious that the distance, quite apart from conditions of service, demanded a system of high tension transmission. The electrical energy is generated as three-phase alternating current of 7,500 volts pressure, and transmitted direct to sub-stations, where the voltage is stepped down by statics and transformed by rotary converters into direct current of 650 volts pressure, the maximum voltage at the train being 600.

The power house is situated approximately about the centre of the line, near Formby, directly on the River Alt, being thus favourably situated as regards economical distribution and a plentiful supply of water. The power house is utilised at the same time as a sub-station, from whence part of the electric energy is distributed direct to the adjacent track. In addition to the rotary converters at the main power house, the scheme embraces three sub-stations, the first being at Sandhills, the second at Seaforth, and the third at Birkdale. The distances of these sub-stations from Liverpool are as follows :—

Sandhills station, distance from Liverpool, 2 miles.
Seaforth sub-station, distance from Liverpool, 3¾ miles.
Formby Power House sub-station, distance from Liverpool, 10¼ miles.
Birkdale sub-station, distance from Liverpool, 16⅛ miles.

Near Liverpool it has been necessary to arrange the sub-stations closer together than on other parts of the line, in order to cope with the considerably heavier traffic of the local trains running from Liverpool to Hall Road and *vice versâ*. The extreme ends of the line—from Sandhills sub-station towards Liverpool, and from Birkdale sub-station towards Southport and Crossens—are each fed by one sub-station, whilst for the intermediate sections of the line two sub-stations participate in supplying energy to the trains, the demand of energy supplied from each sub-station depending on the position of the train between the sub-stations. The sub-stations are situated near the track, thus avoiding any low tension cabling, except a short connecting length.

The system is arranged so that any sub-station can be disconnected if required.

POWER STATION.

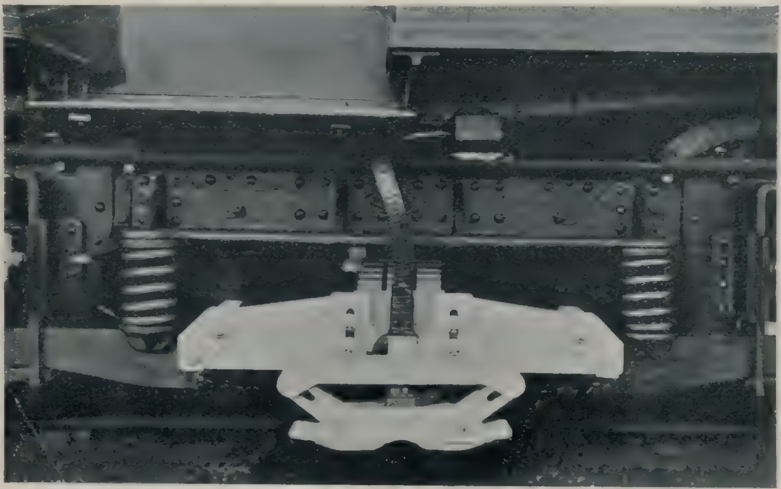
The equipment of the power house has been laid down on simple lines, and there are none of the unnecessary luxuries and refinements which characterise many of the modern power and lighting plants.

It has been erected by Messrs. Thomas Croft and Sons, of Preston, to designs prepared by Messrs. Dick, Kerr and Co., and upon elaborate foundations which were constructed by Messrs. Monk and Newell, of Bootle, under the immediate supervision of the engineers of the Lancashire and Yorkshire Railway Company. It consists of two divisions, the engine room being 280 ft. long by 65 ft. wide, and the boiler house, which is 50 ft. wide, with a similar length of 250 ft. The building consists of a steel roof in two bays, carried upon steel columns, all of which are independent of the brickwork, and which have been made by Messrs. Head, Wrightson and Co., of Thornaby-on-Tees. The engine room is provided with admirable lifting and travelling machinery in the way of overhead cranes, which are capable of dealing with pieces of machinery up to 20 tons, and which are operated electrically. They have been built by Messrs. Jessop and Appleby, of Leicester.

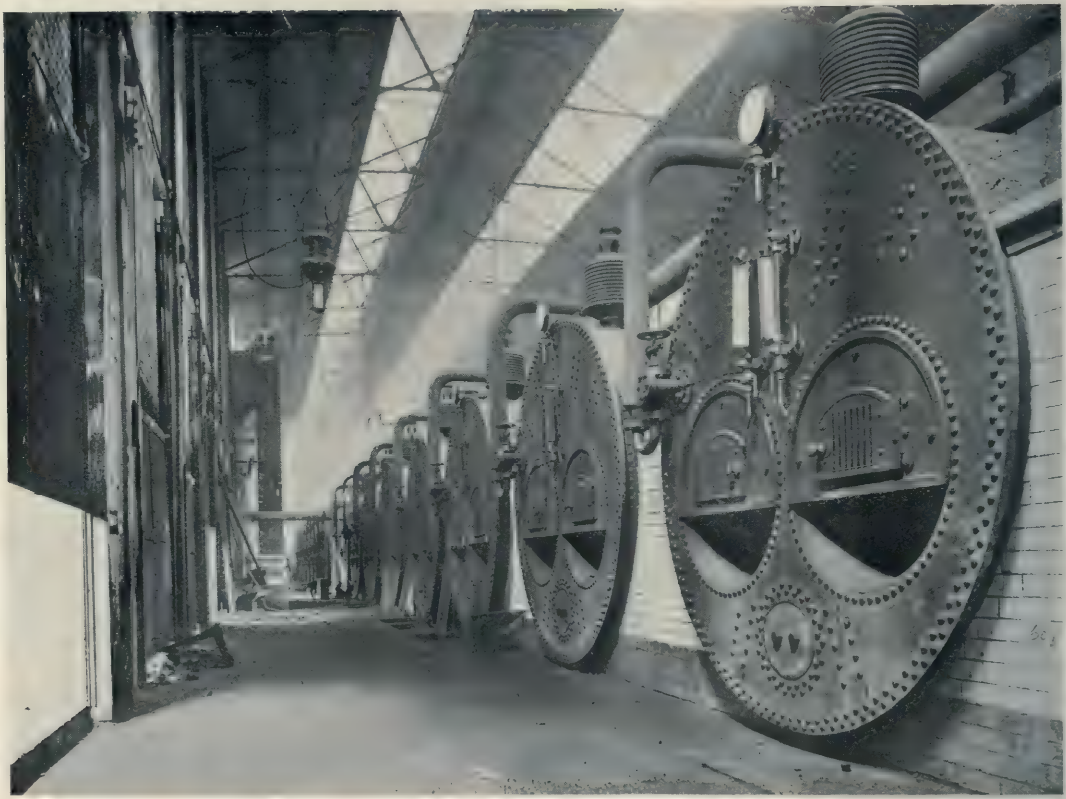
For obvious reasons the size of the units is as large as possible compatible with the running of a reduced service with a good load factor.

There are installed four 1,500 kilowatt units, of which three will, under normal conditions, meet the demands. In addition, there is a fifth unit of 750 kilowatts, which will form a useful link between the larger units, and thus permit considerable flexibility in obtaining a good load factor with high efficiency.

The four main engines are of the horizontal cross compound type, the fifth engine being a vertical cross compound. The horizontal engines have cylinders



COLLECTOR SHOE ATTACHED TO UNDER-FRAME.



VIEW IN BOILER HOUSE.

32 in. and 64 in. diameter, 4 ft. 6 in. stroke, and run at 75 revolutions per minute. The normal load of each engine is 2,310 h.p., with a steam pressure of 160 lb. per square inch, but they are designed to give an overload of twenty per cent. The main engines, as well as the boilers, were supplied by Messrs. Yates and Thom, as sub-contractors to Messrs. Dick, Kerr and Co., Ltd.

Specially powerful and sensitive governors have been fitted to the engine, in connection with which are several devices, designed for securing good parallel running, and for dealing with greatly varying loads. Each governor is also fitted with a special safety stop arrangement, which will completely stop the engine in the event of its reaching a speed ten per cent. above the ordinary working speed, and will also shut down the plant in the event of any failure of the governing gear, yet this is accomplished without interfering with the engine taking excessive overloads, even beyond the full range of the cut-off gear.

Each fly-wheel is 22 ft. diameter, and is directly attached by strong bolts to the rotor, which is otherwise independent of the fly-wheel. The engines are solidly constructed, and of massive proportion, the weight of each bed frame being 14½ tons. Each crank shaft main bearing weighs about 11 tons, and the crank shaft 17 tons, the cranks weighing 5 tons each.

Each engine is fitted with a condensing apparatus, consisting of two Edwards' air pumps worked from the low-pressure tail rod by means of links and levers. The condenser, which is of the jet type, being suitably placed relatively to the cylinder and to the air pumps, and having in connection with it a sluice valve, and an automatic exhaust valve, so that the condensing apparatus can be thrown out of action, and the engines run non-condensing when required.

The alternators are 3-phase, 25 cycles, the larger running at 75 revolutions and the smaller at 94 revolutions per minute, with a pressure of 7,500 volts. These machines, along with the remaining electrical plant, were made at the Preston Works of Dick, Kerr and Co.

The weight of the magnet wheel complete is about 48,500 lb. of which the poles account for 12,800 lb. and the spools 6,350 lb. The complete stator weighs 75,800 lb. Each coil is fully insulated, dried and tested to 15,000 volts before being inserted in the slots.

The constructional features of the 750 kilowatt alternator are almost identical with those of the 1,500 kilowatt sets. There are three direct-current exciter sets, each consisting of a standard Dick-Kerr, 4 pole 100 kilowatt generator coupled to a Willans and Robinson high-speed engine, running at 380 revolutions per minute, the working voltage being 125. They also operate the station lights and ash conveyer and barring motors. The general design of the machine is on the well-known Dick-Kerr lines.

The main switchboard is erected on a gallery over a fireproof high-tension chamber, and is built up of thirty-three 2-ft. panels of enamelled slate. The whole of the high-tension switch gear, oil switches, instrument transformers and bus bars are erected in a fire-proof H.T. chamber, the dimensions of which are 79 ft. by 12 ft., and constructed of steel girders and concrete.

The chief feature of the alternating board is that the high-tension current is confined to the pit below the board, this being effected by the long arm oil switches which are used throughout the system.

The rotor field rheostats are of massive construction, and consist of cast-iron grids insulated with hard micanite and assembled in frames forming layers in a vertical stack which open top and bottom for thorough ventilation.

BOILERS.

There are sixteen boilers made by Messrs. Yates and Thom, of the Lancashire type, each boiler is 32 ft. long by 8 ft. 6 in. diameter, with two flues each 3 ft. 5 in. diameter, constructed for a working pressure of 160 lb. per square inch, the shell plates being 13–16 in. thick, flue plates 9–16 in. thick, and the end plates ¾ in. thick; each shell being in five rings of one plate each. The boilers were tested satisfactorily to 260 lb. per square inch. They are equipped with a full set of fittings and mountings made by the same firm, and are hand-fired. They are arranged in two batteries of eight each in one row.

In each of the down-take flues at the back end of the boilers is fitted a superheater of the Galloway type. The feed pumps were supplied by Messrs. Mather and Platt, Ltd.

The fans for the induced draft work are two in number, each capable of furnishing sufficient air for the consumption of 10,000 lb. of coal per hour with a temperature of the flue gases after passing through the economisers about 400 deg. F. and this under a normal speed of 175 revolutions per minute.

The products of combustion after passing through the economisers enter the fans at a temperature of about 400 deg. F. and are discharged through underground brick ducts to the base of the chimney located just outside the building. This chimney has a height of 60 ft. in order to discharge the products of combustion above the surrounding buildings. The whole of the induced draft apparatus was supplied by the Buffalo Forge Company.

The economisers, working in conjunction with the boilers, were made by Messrs. Green and Son, Ltd., and are constructed in groups of 120 tubes. The installation on the whole contains 1,440 tubes, representing 14,400 square feet of heating surface.

SUB-STATION EQUIPMENT.

The sub-station equipment, save as regards amount of plant, is identical, and to describe one in detail will give an adequate idea of the whole of them. The three largest, Seaforth, Sandhills and Formby, have each four rotary converters, whilst Birkdale has three, provision being made in each case for extensions. Each rotary converter is arranged with its corresponding groups of statics alongside; the high-tension oil switches being placed underground.

The rotary converters are in appearance similar in general design, to the standard d. c. machines.

INTERIOR OF POWER HOUSE.

THE JUNCTION AT SANDHILLS.

They are 8-pole developing 600 kilowatts at 600-650 volts at 375 revolutions per minute.

The average finished weights are: Armatures 10,380 lb., magnets 21,100, complete machine 40,940 lb.

The transformers are of the air-blast type, and have each a capacity of 200 kilowatts. They are circular, and are built up of copper strip wound on edge and insulated with special wrappings repeatedly impregnated and dried. The secondaries are inside next the core, the primaries above and outside. Ample ducts are left between the coils, core, casing and each other to afford free passage for the blast, which entering below, may be regulated by a baffle above.

The blowers, of which there are two in each substation, consist of a standard Dick-Kerr 5-h.p. motor, coupled on a combined base to a Davidson Sirocco fan which is keyed direct on the motor shaft. The capacity of each fan is 8,000 cubic feet of air per minute at a pressure of 2 in.-3 in. of water.

The sub-station switchboards consist of a high-tension and low-tension side, the latter having been supplied by Elliott Bros., the switches and circuit-breakers being of the standard Dick-Kerr pattern.

HIGH-TENSION TRANSMISSION.

The high-tension cables leading from the power house are arranged in each case in triplicate. Under ordinary working conditions all three cables are used, but in case of breakdown of any one of the cables the two remaining ones can do the work without the drop or the current density exceeding the permissible limit.

The whole of the cables were manufactured and laid by Messrs. W. T. Glover and Co., Ltd., as sub-contractors. The extra high-tension cables are of the triple triangular type, diatrine paper insulated lead-covered and armoured laid on the solid system.

Four different sizes of cable were used :—

37–15, 37–16, 19–15, 19–16.

The length of each being respectively: 13 miles, 6½ miles, 6½ miles and 18 miles—a total of 44 miles.

The insulation consists of Manilla paper impregnated with diatrine by a special process which ensures that the paper is thoroughly impregnated, the surplus compound being removed from the surface of the paper by means of a special apparatus.

The armouring is of galvanised steel wires ·8 to ·1 in. diameter, which acts as a mechanical protection in addition to making a most satisfactory and efficient earthing conductor.

The joints are of the plumbed-lead sleeve type, the lead sleeve being filled up with diatrine compound.

The troughs are made of stout wood, tarred and creosoted, filled with compound, and covered over with tiles. Specially prepared impregnated wood bridges support the cables at 18 in. intervals. The cables are laid for the most part in the six-foot way, and where they pass over bridges or in exposed situations are laid in stout steel troughs.

PERMANENT WAY.

The permanent way is, for the purpose of distributing and returning the electric current, equipped with two additional rails. One of these current rails is brought alongside each track on insulators, whilst the other rail is placed between the running rails, uninsulated on the sleepers, this forming the principal part of the return circuit. Whilst the joints of both the third and the fourth rail are bonded in the ordinary way in the manner described below, the fourth rail is, also, cross-bonded to the running rails, the ends of each running rail being connected by such a bond to the fourth rail, and, whilst, by this arrangement, the troublesome bonding of the running rails is avoided, as also the complications involved by using an insulated fourth rail for the return, the further advantage is obtained that the running rails participate to a marked degree in conducting the return current, thus increasing the conductivity of the return circuit, with consequent reduction of drop. No collector shoe is provided on the train for the fourth rail, the current being delivered through the wheels to the running rails, and thence, through the cross-bonds, to the fourth rail.

The installation of this rail also makes it a comparatively simple matter to renew the running rails without unduly interfering with the continuity of the return circuit.

The third and fourth rails are both of equal section and consist of mild steel of special high conductivity, the resistance being proved by test to be not greater than seven and a-quarter times that of pure copper. As a matter of fact, the average resistance is somewhat lower.

The rails have been supplied by the North-Eastern Steel Company, of Middlesbrough, are of Vignoles section, weigh 70 lb. per yard, and are in lengths of 60 ft.

The third rail is supported at intervals of about 10 ft. on insulators of reconstructed granite, held in position by two clips, the centre of the rail being exactly 3 ft. 11½ in. from the centre line of the track, and the top of the rail 3 in. above the surface of the track rails, this dimension being that agreed upon by all the main line railway companies, at a meeting held at Clearing House, on March 3rd, 1903, in order to obtain uniformity, in case of extensions of third-rail system. It is of ample section to convey the full amount of current required by the trains, when between two sub-stations, without causing any appreciable loss in voltage. Generally, the third rail is placed in the 6 ft. way between the tracks, but occasionally it is brought outside the track, to suit special conditions. At all level crossings gaps in this rail have been provided of such a length that there can be no risk whatever to the public; where these gaps occur the third rails are bonded with cable underground. Timber guarding has been provided at all the busy places on the line, to prevent the possibility of any person coming into contact with the third rail.

The fourth rail is supported on wooden blocks, and is placed in the middle of the 4 ft. way between the two running rails.

At most stations the third rail is interrupted and the ends are connected by cables to section switches. This apparatus consists of four knife-switches, one for each end of the up and down line, which, in the ordinary way of working, are connected in parallel. By cutting out one of these switches in two adjacent boxes, any part of the up or down line may be made currentless.

The fish-plates at the expansion joints are of special design, and properly slotted to provide for any change of length which may take place in the 300 ft. section. The terminals of all the bonds are of solid copper, and are expanded in the bond holes by means of screw or hydraulic compressors. Each track rail is bonded to the fourth or negative rail by means of flexible cable bonds supplied by the Forest City Electric Company.

THE ROLLING STOCK.

The trains consist in most cases of two first and two third-class cars, the latter being at either end, and equipped with two motor bogies each bogie carrying two 150 h.p. motors. There are, consequently, eight motors per train. The current is conveyed to the motors through a cast-steel slipper, attached to a beam on each side of the motor bogie, which rubs on the third rail.

Both types of cars are 60 ft. long and 10 ft. wide, being the widest carriages in this country, and have 8 ft. wheel base bogies fixed 40 ft. 6 in. centre to centre apart. They are arranged with straight sides, match-boarded below the side lights.

There is a monitor or clerestory roof 6 ft. 2 in. wide, the top being 12 ft. 7⅞ in. from the rail level. The vehicles are painted in the company's standard colours of brown and crimson lake. The motor cars are divided into two main compartments with a luggage and motor compartment; access being obtained through entrance vestibules which are recessed back at either end, the whole arrangement being so designed that the doors shall not project beyond the 10 ft. width when extended. Immediately inside the compartments the seats are placed longitudinally against the side of the car so that ample space is allowed for the inlet and outlet of passengers. The cars are otherwise fitted with cross seats and reversible backs with a passage between, the first class accommodating two on either side and a total of sixty-six passengers per car, the third class seating three on one side, and two on the other, and a total of sixty-nine passengers per car, the total accommodation in a normal train being in this way 270 passengers.

Between all cars vestibule gangways are provided, and it is therefore possible to pass from one end of the train to the other, only those between first class being for the use of passengers.

All cars are electrically lighted and heated, the necessary switches being placed in the vestibule entrance of each coach, and so arranged as only to be accessible by means of a special key carried by the guard. There is a through bell communication which enables the guard, by means of a special key, to give the motorman the signal to start from any vestibule entrance on the train.

The total weight without passengers of each trailer car is 26 tons, and of each motor car 44 tons, making the total weight of each four-car train 140 tons, and a length over all of 248 ft. 6 in.

The bogies for the trailer cars are the company's standard carriage bogie, the frame being composed of angle-steel section, and channel-steel bolsters. Special springs have been introduced to ensure easy riding.

The current is collected on each side of the motor bogies by cast-steel slippers weighing about 90 lb. each. On straight runs of third rail there are thus four shoes collecting at one time. From these slippers which are suspended by forged slotted links from a wooden beam carried on extensions on the bogie, a highly flexible lead of special construction is carried to a fixed terminal from which the main cables pass to the controller.

The vacuum brake is used on the trains, thus making them adaptable for service with the company's other rolling stock and locomotives at any time.

The motor compartments have, with the exception of the roof, which is covered with sheet-steel plates, been lined with uralite, the floor also being fire-proof.

In addition to the cable troughs, in which the cables are placed for conveying current to the motors, and equipment, being lined with uralite, the whole of the floor over the motors is covered with the same material and thin steel plates. All the trains carry fire appliances, and ample steps have been taken to ensure safety in this respect.

As has been already stated there are eight motors on a complete train, which drive on to the axles through single reduction gear. They are of the Dick-Kerr 4–A railway type, rated to develop 150 b.h.p. at an armature speed of 470 revolutions. The weight of the complete motor is 6,050 lb., the armature 1,920 lb., and the gear wheels and housing 500 lb. Its main features are similar to those of the standard traction type.

Photo. by N. S. Kay, Bolton.]

MR. JOHN A. F. ASPINALL, M.I.MECH.E., M.INST.C.E.

One of the most interesting features of the equipment is the method of control, which may be termed the direct multiple control system, in contra-distinction to the multiple unit, the main difference in the systems being that in the case of the former it is possible to control the whole equipment of the train by means of two main cables. Previously, the great difficulty in the way of such a simple arrangement lay in the construction of the controller, it being practically impossible to carry the whole of the current through one controller.

In the Dick-Kerr system this is rendered possible by the use on the controller of the metallic shield blow-out, which is part of the standard design of their tramway and railway controllers. They contain two power cylinders, each controlling one-half of the train, that is, one motor car is actuated from one cylinder and the rear motor car controlled from the other. Without, therefore, interfering in any degree with the completeness of the train, it would be possible to divide one of the present trains into two distinct units.

The train is entirely operated by the motorman from his cab at the front, in which there is a Dick-Kerr D.M. four-controller, capable, in conjunction with eight reversers, which are bolted up adjacent to their various motors under the floor, of operating the eight motors on the pair of motor cars.

The reversal of direction of the motors is effected by means of a special apparatus operated by the controller reversing barrel.

The complete scheme, with the exception of the rolling stock, which was made at the Horwich and Newton Heath Works of the railway company, was entrusted to Messrs. Dick, Kerr and Co., Ltd., of London, Preston and Kilmarnock, who may take credit for being the first firm in England to carry out and complete a main line electrification. The work of electrifying the line has been completed in a remarkably short time. Twelve months ago the work of construction had not been begun, yet on March 1st, 1904, a scheme embracing 47 miles of permanent way, a transmission plant of 12,000 h.p. and a complete train system has been carried out. Moreover, this has been achieved without interference with the running of the steam service. These results are mainly due to the untiring energy of Mr. Aspinall, seconded by the efforts of the contractor.

ANDREW CARNEGIE,
LL.D.,

President of the
Iron and Steel
Institute.

Mr. Andrew Carnegie's latest claim to distinction is the offer of a donation of £300,000 for the erection of a Union engineering building, which has been accepted by the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, and the Engineers' Club. There is scarcely any need to remind technical men that he is at the present time filling with conspicuous ability the position of President of the Iron and Steel Institute. Mr. Carnegie was born at Dunfermline, on November 25th, 1837, and went to America as a boy of thirteen. His rise was coincident with the boom in railway building which set in after the American Civil War. Important factors in his career have been an extraordinary foresight and grasp of opportunities, and an infallible judgment of men, as exemplified in his choice of business associates. The Carnegie libraries of this country have exerted an influence on the masses the extent of which will perhaps never be fully realised.

The War between Russia and Japan :

A MONTHLY SURVEY.

BY

N. I. D.

A SIMILE borrowed from the theatre has been used by nearly every commentator upon the present war, in referring to the sudden cessation of trustworthy news of the movements of both parties, since the second week of the war. We have had, it is true, driblets, a corner of the curtain has been raised every now and again, but of the general campaign, there have been no tidings. It is as if we had seen the naval curtain raiser, and were waiting for the first act of the great military drama.

It is not to be denied, of course, that Japan is quite right to keep her movements shrouded in uncertainty. News telegraphed to England can be re-telegraphed to St. Petersburg, and thence made known to Admiral Alexeiff, General Stoessel, and Vice-Admiral Stark, or their successors. But, at the same time from certain indications which have occasionally appeared in the Press, it is quite possible to deduce a probable scheme of action.

Last month there was only an opportunity of stating the facts about the naval encounters which crowded thick and fast upon each other's heels, and to give in detail a comparative statement of the naval strength of the opposed Powers. This month some particulars may be added, speculative in the main, but founded upon fairly reliable reports, as to the relative military strength of the belligerents.

The Japanese army can rely in an emergency upon a regular army of 7,500 officers and 190,000 men. These are divided into 52 three-battalion regiments of infantry, 55 squadrons of cavalry, 19 regiments of field artillery, with six guns to each battery, 20 battalions of fortress artillery, 14 battalions of engineers, including one of railway specialists, and thirteen transport battalions. To these figures are to be added 35,000 officers and men in the reserve, and 200,000 men of all arms in the territorial army, making a total in round numbers of 430,000 officers and men, with 1,200 guns and 90,000 horses.

How many of these are already landed in Korea? We may assume the fighting strength of a Japanese division at 14,000, to be added to which is the reserve brigade of the division, of about another 6,000. It has been stated that three divisions have been landed at various points in Korea, Masampo, Fusan, Chemulpo, and Chenampo. In Korea, therefore, Japan has probably an army of from fifty to sixty thousand combatants.

What force has Russia to oppose this? It is evident that the figures which were supposed to be accurate before war broke out were very largely exaggerated. We were led to believe for instance, that the garrison at Port Arthur was 30,000 strong. It is now known to be about 15,000. Allowing, then, for such exaggeration, and allowing also for garrisons, railway guards, and convoys, it is doubtful if the Russian army on the Yalu numbers more than 25,000. Two months ago it might have been urged that the Trans-Siberian railway would soon remedy this, that Russia would simply pour troops into Manchuria and Korea. But, as is often the case, two months have served to demonstrate the utter futility of peace experiments as a criterion of what can be done under stress of war conditions.

The Trans-Siberian Railway is the one link between the Russian army in the Far East and its source of supplies, of men, munitions, and food. The sea is closed to the Russians, the recalling of Admiral Virenius's squadron from Djibutil proves it. Everything that the force under Admiral Alexeiff needs must pass over a single line of railway, which could be thrown hopelessly out of gear by a daring and successful raid by any of the many turbulent tribes in Mongolia.

The line is over six thousand miles in length from Moscow to Vladivostok. There is only one tunnel in the whole line, but there are no fewer than thirty miles of bridges, the breakdown of one of which would disorganise the whole of the traffic, already known to be in a frightful state of congestion. From Moscow to Irkutsk the line is laid with some care, but thence to Harbin it is little more than a sheep track in places, and luckless travellers have described their experiences in pathetic language. Lake Baikal is, of course, the most difficult obstacle on the whole line. The attempt to run trains across the ice has partially failed, and the passage has mostly to be made on sleighs. The journey takes five hours, and the piercing cold out on the lake has already resulted in many fatal cases of frostbite, besides rendering many of those who survive their injuries useless as fighting units. It is true an attempt is being made to carry the railroad round the shores of the lake, but this must necessarily be a matter of some time.

The line itself has a carrying capacity of about 1,400 men a day, with horses and provisions. But it is significant that in those descriptions of the railway which have appeared since the war began, no mention is made of horses, except in one instance, when a correspondent remarks: "In the whole course of my journey (from Vladivostok to Moscow), I saw no horses being hurried forward, though I understood that there were several thousand expected." It would appear, then, that the much-talked-of superiority of the Russian cavalry is to be minimised by the lack of horses.

To come back, however, to the situation in the theatre of war, it will have become obvious that by their naval victories and the rapid pushing forward of their land forces, the Japanese have thrown the Russians back on to their frontier, which may be defined as a straight line from Port Arthur to Vladivostok, cutting the Yalu River at about An-Tung, where it is believed the main body of their army was at one time gathered. This may be taken as the centre of the Russian position. Japan's scheme of action appears to be, then, to keep both ends of the line busily engaged warding off attacks by sea while she steadily prepares a heavy blow at the centre by land. And to this end her naval supremacy lends her the necessary aid. The original intention was to land her troops at Fusan and Masampo. But the first victory at Port Arthur opened the Yellow Sea to her transports, and she promptly proceeded to put a division ashore at Chemulpo, and to occupy Seoul. Later events have rendered it possible for her to send her transports even further up each coast of the peninsula, and she is now disembarking men at Chenampo on the east and Gen Sen on the west, both divisions concentrating probably at Ping Yang, and meeting there some portion at least of the division landed at Chemulpo, which will, in all probability, be somewhat weakened, first by the fatigues of the march, and secondly, to supply guards for the communications. As soon, however, as Ping Yang is a properly equipped base, these can be withdrawn.

Such appears to be the outline of the Japanese plan of campaign. It was probably the original intention to march the divisions right through Korea to the Yalu, but the unexpectedly rapid disposal of the Russian fleet led to a modification which will eventually save both time, men, and stores. The landings reported on the Liao-Tung Peninsula, and at Possiet Bay, if they have any foundation, seem to be mere diversions, with the same end in view—the constant occupation of the forces at the terminal points of the frontier with their own safety, while the great blow at the heart of Russian military power in the Far East is preparing. That the Japanese authorities realise the immense moral value of an initial success is certain, and that no move will be made until success is, humanly speaking, assured, is no less so.

The naval movements have not been of very great importance since the first article appeared. Those in the Far East have been mainly in the nature of reconnaisances, for the bombardment of Vladivostok could not have been anything more, and the engagement at Port Arthur in the early morning of March 10th, while important enough in its way, was little more than an outpost affair. Admiral Togo, in his report, says that one of the divisions of destroyers posted itself so as to watch the entrance, and the other was employed in laying mines "in various places," obviously with the object of sealing up the port. At about half-past four the watching flotilla came into contact with a division of Russian destroyers, and a severe fight ensued, in which the Japanese lost seven killed and eight wounded. The vessels were not disabled. Two Russian destroyers, in making their escape after the action, fell in with the Japanese division engaged in laying mines. A further engagement took place, lasting about an hour, from which one destroyer escaped—the other, the *Stereguschtchni*, was sunk, the survivors of her crew being taken on board the Japanese destroyer *Sazanami*. In this action the Japanese lost two more killed and three wounded. According to Admiral Alexeiff's report, the Russian losses were only four slightly wounded, but it seems certain that this must be incorrect.

The Japanese squadron subsequently bombarded the port rather heavily, but with what amount of success is not yet certain.

The European Powers have been very careful to impress upon Japan the necessity for strict observance of the neutrality laws, and the prolonged stay of the Russian fleet under Admiral Virenius at Djibutil is the more remarkable. The fleet consisted of the battleship *Osslabia*, the cruisers *Dimtri Donskoi* and *Aurora*, and some twenty torpedo vessels. In passing, it may be noted how little things emphasise the difference between the administrative powers of the belligerents. At one time Russia had this squadron in the Levant, and at about that time the two new Japanese cruisers *Nisshin* and *Kasuga*, manned by scratch crews, with their heavy guns unmounted, and much internal work unfinished, set out from Genoa. They were shadowed through the canal and the Red Sea by the Russian ships, and everyone expected to hear at any moment that they had both been sent to the bottom. And yet to-day they are safely in Yokosuka, fitting out for service, and the Russian fleet is pottering about the Eastern Mediterranean, "a *quantité négligeable*." It is reported that this squadron will in the spring be reinforced from the Baltic. In what condition the vessels under Admiral Virenius will be then passes comprehension. One torpedo boat we know to be *hors de combat* at Port Said; another has been sunk; the *Dimitri Donskoi* has been reported to me in a communication from a friend to be in a pitiable condition, and the flagship is far from being wholly effective. To keep these ships hanging about there another six months is as suicidal a policy as was the leaving of the Port Arthur fleet at anchor in the open roadstead. The two actions are a striking commentary upon that fatal lack of comprehension of what a navy is for which has marked the Russian naval administration for the past three months, and which was admirably illustrated in an article in the *Kronstadski Viestnik*, which declared that the passive attitude of the Russian fleet in the Far East was of immense importance, since its presence covered the right wing and rear of the army, as well as the railway connections with Port Arthur. The article went on to say that by this passive attitude a landing by the Japanese on the east or west of the Liao-Tung Peninsula was rendered impossible, and that if the Russian fleet were despatched in search of the enemy it would amount simply to leaving the coast line at the mercy of the Japanese. If events do not further falsify this peculiar idea of the use of a fleet, naval experts, both in this country and the United States, have strangely misapprehended the situation.

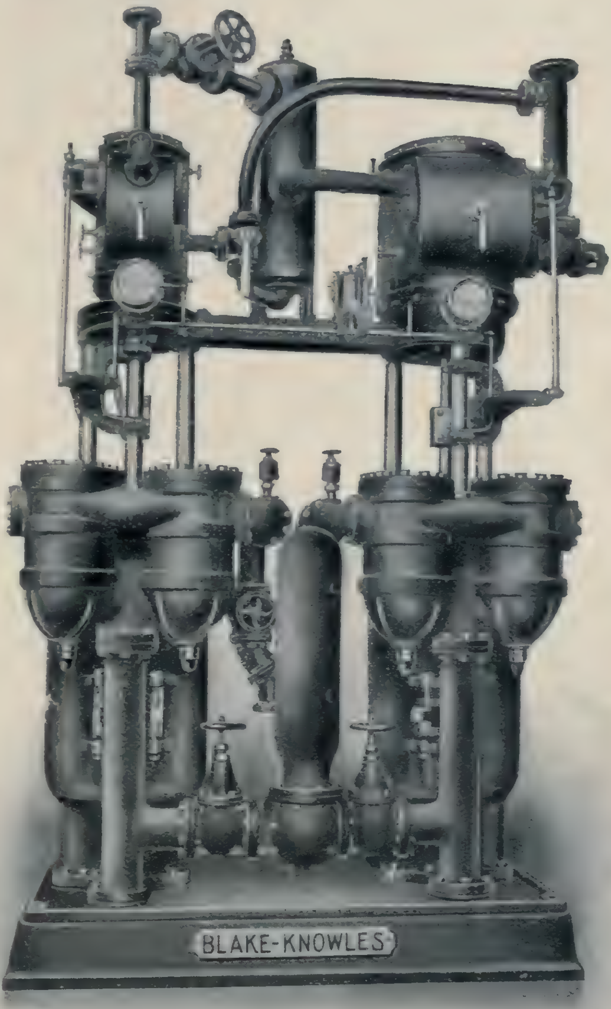
Vertical Simplex Cross-Compound Centre Packed Plunger Pumps for Lots Road Generating Station.

WE illustrate on this and the following page the type of vertical direct-acting boiler feed pumps which have been supplied by Messrs. The Blake and Knowles Steam Pump Works, of Queen Victoria Street, E.C., for the Lots Road Power Station installation. Each set is provided with a 16-in. high-pressure steam cylinder and a 9½-in. pump cylinder of 18-in. stroke; also a 26-in. low-pressure steam cylinder and a 9½-in. pump cylinder of 18-in. stroke.

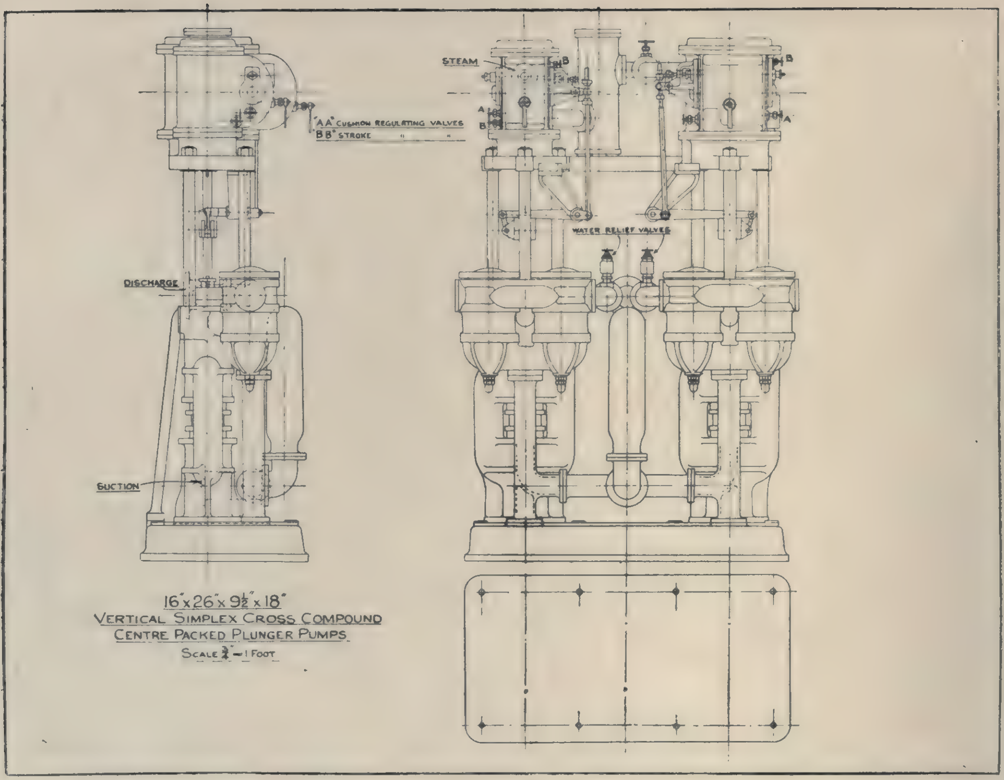
The complete set consists of two vertical simplex pumps connected so that they run as a cross compound machine, but arranged so that each pump can work independent of the other. One pump has a small steam cylinder for high-pressure steam, exhausting into receiver, and from thence into the low-pressure cylinder, thus using the same expansively.

The valve motion has been specially designed for the work, so that high pressure steam can be used, and this at a high degree of superheat. The water ends are also of special design, the pump cylinders being of the plunger pattern, centre packed, and the plungers highly polished, so as to reduce the frictional conditions to a minimum. The material used for the plungers is hard chilled iron. The connections between the two steam cylinders and the suction and delivery arrangement between the two water cylinders enable either side to be operated alone. In fact, practically a duplicate arrangement of pumps can be arranged. These pumps are built for a working pressure of 225 lb. and they have to deliver at the rate of 300 gallons per minute, while running at 18 double strokes, this being equal to a delivery of 18,000 gallons per hour, or sufficient to feed water for a turbine plant of about 10,000 h.p.

Seven sets are comprised in the installation, the first of which was run to the satisfaction of the engineers at the station, before final instructions were given to proceed with the balance of the order. This is the largest order for boiler feed pumps for this service that has ever been placed.



PART OF THE PUMPING PLANT AT LOTS ROAD POWER STATION.



SEVEN SETS OF THESE PUMPS HAVE BEEN INSTALLED AT LOTS ROAD BY MESSRS. BLAKE AND KNOWLES.

THE ELECTRIFICATION OF THE METROPOLITAN—A SECTION EQUIPPED WITH CONDUCTOR RAILS.

Messrs. Graham, Morton and Company's New Works.

On March 11th about one hundred and fifty engineers and representatives of the press visited Leeds for the first informal inspection of Messrs. Graham, Morton and Co.'s new engineering works at Hunslet. Before the business of the day commenced an excellent luncheon was served, and following a tour over the new premises an inspection was made of the large installation of inclined retorts at the New Wortley Gas Works, this being the nearest available piece of work among the many contracts which the company has on hand at home and abroad. Messrs. Graham, Morton and Co. are to be congratulated on the removal of their establishment to a position three miles from the centre of Leeds, for not only will the company be able to carry out operations commensurate with its opportunities, but it will possess one of the best designed works in the United Kingdom or even America. We are reminded that though Messrs. Graham, Morton and Co., Ltd., are a young firm they have already executed some large contracts. In 1901 the firm undertook an installation of Inclined Retorts at Edinburgh, completing it within the short period of nine months, its value being £120,000.

That the new undertaking has been carried through with commendable celerity will be understood when it is stated that on May 16th, 1903, the site on which the works and offices now stand was an unoccupied field. Five and a-half months later machinery and men were at work, and the office staff was installed in its quarters. An important point about the new scheme is that provision has been made for a siding connecting the works with the Hunslet branch of the Great Northern Railway.

The new premises comprise two blocks of buildings —the offices and the works. The latter are in the form of three bays, and are of steel and glass, on a foundation of brick and concrete, the main floor being 400 ft. long and 140 ft. wide. The roof and sides are of glass, supported by steel girders.

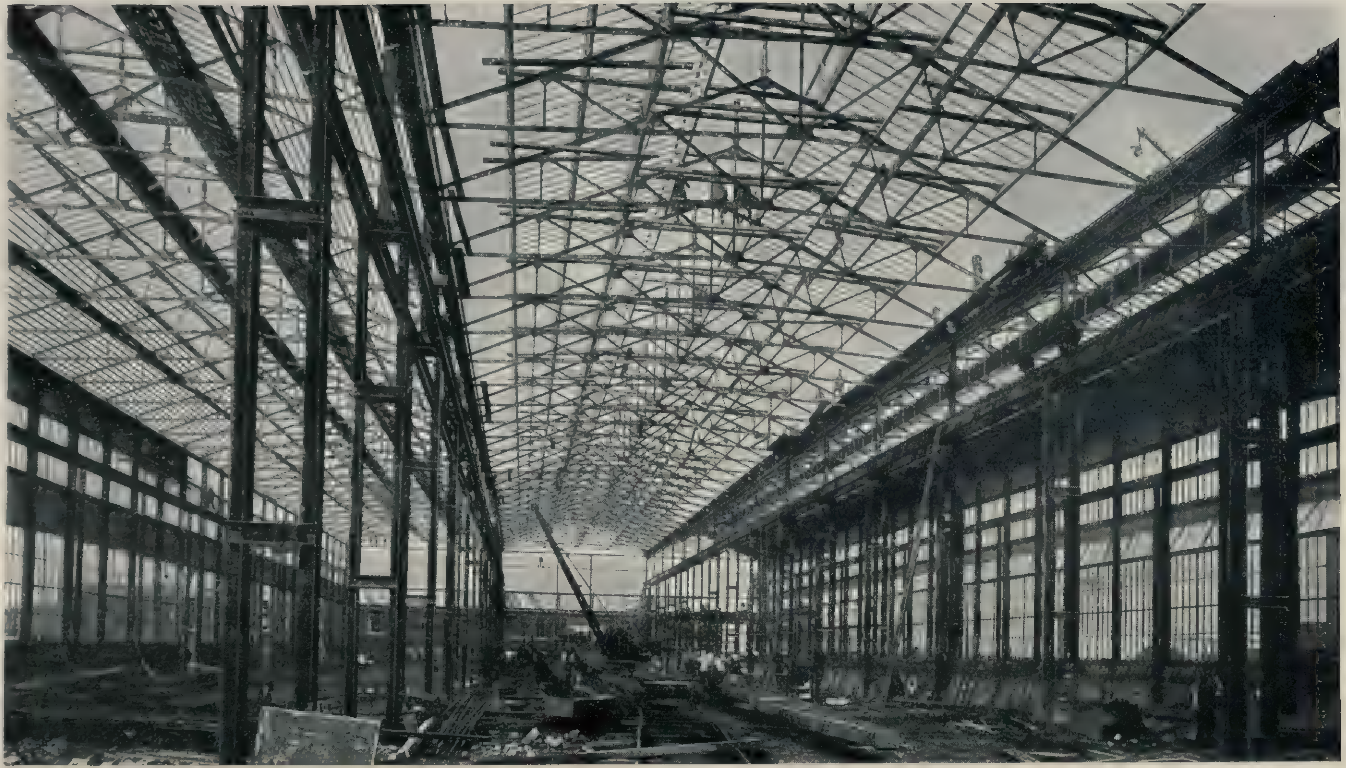
In the section devoted to constructional ironwork manufacture a number of bridges were to be seen in the making. Fifty-seven are for the North-West Provinces of India, to the order of Bengal; seven are to the order of the Great Western Railway Company; others are for the Halifax Corporation, and the remainder are in fulfilment of Admiralty and War Office contracts. In the centre of the floor sections of roofing for tramway stations were being completed; a second group of men being engaged on elevating and conveying work for Melbourne and Sydney, Australia.

The tool shop, where all the tools required in the works are manufactured, attracted a good deal of attention, and a good deal of interest naturally centred in the power house, which has two sets of Bellis and Morcom's high-speed engines, coupled direct to 150 kilowatts generators (equal 200 h.p.) each running at 450 revolutions per minute, and generating 220 volts.

The motors were all manufactured by the Phœnix Dynamo Manufacturing Company, Ltd., of Thornbury Works, Bradford. The total h.p. is 234 h.p. of which 84 h.p. is fitted to the four three-motor cranes, and the remaining 150 h.p. is used for driving the various shops as follows: 25-h.p. air compressor, 15-h.p. plating shop, 15-h.p. plating shop, 15 h.p. special machine, 7½-h.p. corve shop, 15-h.p. fitting shop, 10 h.p. fitting shop, 7½-h.p. chain shop, 7½-h.p. idler shop, 7½-h.p. tool room, 7½-h.p. fan room, 15-h.p. pattern shop.

The pattern shop and stores are in a separate building, which was erected and occupied by workers in the space of a fortnight. It is 60 ft. long, 24 ft. broad, and 21 ft. high. For the works, engine and boiler houses, 54,600 square feet of glass were used, and another 6,950 for the offices. The weight of the iron work employed was 343 tons of steel joists, 323 tons of sectional steel, and about 50 tons of bolts. The area covered by the works is 420 ft. by 150 ft., or 7,000 square yards; by the engine and boiler houses 50 ft. by 55 ft., or 306 square yards; by the offices 270 ft. by 41 ft., or 1,230 square yards, in all an entire acreage of 76,824 square feet.

Of the offices it may be said that they are in every way worthy of the new workshops, no expense being apparently spared to attain efficiency.



AN INTERIOR VIEW AT THE NEW WORKS OF MESSRS. GRAHAM, MORTON AND COMPANY.

THE TRANSATLANTIC ENGINEERING SCHOOLS.

Will they produce results commensurate with the capital outlay connected therewith?

BY

E. C. DE SEGUNDO, A.M.INST.C.E.

The following criticisms are consequent upon Dr. Mullineaux Walmsley's recent paper read before the Institution of Electrical Engineers. The author deprecates excessive elaboration in the equipment of technical schools, and urges the necessity of fostering the students' mechanical instinct.—ED.

DR. MULLINEAUX WALMSLEY deserves the thanks of the engineering profession for the exceedingly painstaking manner in which he has collated the facts and figures obtained by him during his tour in the United States and Canada, and his paper, entitled "Transatlantic Engineering Schools and Engineering," which was read at a meeting of the Institution of Electrical Engineers on February 25th, will probably form the subject of much useful discussion and criticism.

Every thinking man must realise that the education of the craftsman, whether he be destined to work with his hands or with his head, is an important factor in the commercial prosperity of every country, but at the same time I think that—given suitable capabilities in the individual—the degree of efficiency to which these capabilities may be developed will not wholly depend upon educational facilities.

It is a significant, if disappointing, commentary upon the wonderful development that has taken place in recent years in the equipment of engineering laboratories—both in Europe and on the other side of the Atlantic—that in the large majority of instances it is still true that the men who occupy the more responsible positions in engineering are men who have had, comparatively speaking, small educational opportunities. It may be urged that a sufficient period of time has not yet elapsed to enable one to properly gauge the effect upon engineers, as a body, of the highly scientific training which students can now obtain at moderate fees at most of the leading technical institutions and universities. Be that as it may, I am inclined to think that the present system of technical education tends to aim at accomplishing too much and seeks to substitute information of the nature of "book learning" for the mechanical instinct and maturity of judgment, which can only be obtained by actual experience in the everyday practical work of overcoming difficulties and solving problems of all sorts.

One's education is made up of two parts, that part that is given to one, and that part that one acquires after leaving the training institutions. Of the two, the latter is the more important, particularly in such a profession as engineering. Obviously, the first part of a student's education should be designed to place him in a position to continue his education himself in the most useful manner possible. If a student could map out his future with any degree of certainty, he would be able—in consultation with the various professors—to decide upon the curriculum which would include the subjects with which he intended to occupy himself in after-life, and he would also be able to decide how far each of these subjects should be usefully pursued while in the training institution. Unfortunately, with comparatively few exceptions, it is not possible for an engineering student to foresee in what particular branch of engineering his energies will in the future be exerted, and consequently the engineering curriculum in most technical colleges is drawn up with a view to do the greatest good to the greatest number. The course of study is suggested by the professors in consultation, no doubt, with manufacturers, employers and others, but the very endeavour to include in the curriculum the treatment of a sufficiently varied number of subjects to give the average man a good average send-off, as it were, on his leaving college, threatens to defeat its object by embracing too wide a field and by carrying the treatment of the various subjects up to too high a plane.

I think it is possible that something of this sort may have been in Dr. Mullineaux Walmsley's mind when he wrote the following words on page 23 of his paper. He says, "Another class, from which the engineering colleges of America draw quite an appreciable proportion of their strength in earnest and capable students, is furnished by those who, not having been able to afford the luxury of a college training in early life, have acquired by dint of hard work and perseverance, or by some stroke of good fortune or inheritance, sufficient capital or resources to enable them to face a four years' college course, and thus to complete a training which was prematurely interrupted earlier in life. It is not too much to say that these men, with their practical experience of life and its troubles, form a very important background to the whole student class of the colleges. From the necessities of their previous practical training it follows that they are men endowed with grit and perseverance, who, having come to college with a well-defined purpose, do not intend to allow any obstacles to interfere with their aim, and thus they form a valuable nucleus round which the more earnest work of the institution gathers."

There can be no doubt whatsoever that if a man has a definite idea of the particular course of study which he should pursue in order to fit himself for the carrying out of duties which he can clearly see and define, he will learn more that will be of use to him in a week than a student equally endowed intellectually would learn in a year in the process of pumping general information into himself—or having it pumped in for him.

In the discussion which followed Dr. Walmsley's paper, Mr. Cooper adverted to the significant fact that no employer had taken part in the discussion. It would certainly have been very interesting, and I think important, to have had the views of those who have employed engineers turned out by the training institutions as to their general efficiency and value. In fact, it is only in consultation with those who have to put the finished product to practical use that useful information can be obtained in modifying or altering the courses of study laid down for engineering students at the various technical and other colleges, and, indeed, it is to be hoped that a conference between professors and employers will be arranged to discuss the very important question suggested by Dr. Walmsley's paper, namely, whether it is really necessary for us to spend the enormous sums in the equipment and maintenance of technical institutions in this country that have been spent in America, Germany and elsewhere in Europe in order to maintain the same standard of mechanical efficiency for English engineering students as, it is alleged, is to be found on the Continent and in America.

I enjoy the privilege of having obtained my theoretical training under one of the most able and practical professors of engineering of recent times, namely, Dr. Alex. B. W. Kennedy. It is not too much to say that some twenty-two years ago the engineering laboratory at University College, London, was better equipped than that of any other institution in this country, and that it is mainly due to Dr. Kennedy's untiring efforts that the value of a properly-equipped engineering laboratory as an adjunct to the theoretical training to be given to engineers became recognised throughout the country, and, I venture to say, throughout America. Although Dr. Kennedy was very much hampered in the equipment of his laboratory by the smallness of the funds that the authorities of University College placed at his disposal, I am inclined to think that the University College laboratory of those days possessed all the necessary tools and equipment for giving the students a very good insight into the practical detail of their theoretical studies, and, I venture to think, that that is as far as the practical training in an engineering laboratory ought to go. It is most interesting to read Dr. Walmsley's accounts of the equipment of the transatlantic engineering schools which he has visited—take for instance, his description on pages 9 to 12 of the equipment of the engineering department of the Cornell Institution. But on reflection one cannot help realising that all the functions of the various machines and apparatus in a laboratory of this description are pre-arranged, and as the machines themselves are, in a sense, kept under a glass case at 60° F., the same results invariably follow the same causes, which, although a strictly accurate philosophical axiom, does not somehow seem to be borne out when one gets down to practical work with machines outside of the engineering laboratory.

I cannot help thinking that the tendency of excessive elaboration in the equipment of technical schools is to form the idea in the student's mind that success in his future work as an engineer will be largely a matter of applying formulæ, whereas the object of an engineering student's training should be to instil into his mind correct fundamental principles, to develop the habit of accurate observation, quick discernment and rapid deduction. To teach him to be always alert, always ready to learn, always inquiring into the reasons of any apparent discrepancy between cause and effect, and thus to continuously develop that most valuable, in fact, absolutely essential characteristic of the useful engineer, namely, the *mechanical instinct*.

THE ORGANISATION OF COAST DEFENCES.

BY

CAPTAIN C. G. VEREKER, R.A., *"Duncan" Gold Medallist, 1903, and* CAPTAIN C. S. S. CURTEIS, R.G.A., *"Duncan" Silver Medallist, 1903.*

Assuming the probability of raids by a foreign naval Power, what are the best preparations to repel them so far as the construction, armament and organisation of our coast defences are concerned. The question is one that has been freely discussed of late both in connection with events in the Far East and also by those who think that our coast defences are capable of great improvement. The following extracts from an essay contributed to the "Journal of the United States Artillery," refer primarily to the American seaboard, but also include much that is applicable to the coast defences of the British Empire. We therefore consider them of sufficient importance to be dealt with practically *in extenso*.—ED.

IN the following article we assume the probability of raids by a foreign naval power. Most people agree that torpedo-boat attacks are likely to take place during the earliest stages of a war, and even in some cases before war is officially declared. At this period it is probable that the reserve ships would be mobilising and squadrons collecting and preparing for sea, and the moral result of a successful raid would be very great. An energetic enemy would spare no trouble in carrying it out, and would not hesitate to sacrifice a few torpedo-boats when even one getting through the defences might do incalculable harm.

The different classes of coast defences and the form of raid to which each is most liable can be summarised as follows :—

Class of defences.	*Most probable form of raid.*
Fortresses at home ..	By torpedo-boats.
Fortresses and coaling stations abroad.	By torpedo-boats (if within reach of an enemy's port). By strong force, if command of sea temporarily lost.
Harbours of refuge at home.	By cruisers or torpedo-boats and pinnaces carried by cruisers.

As each port should be so armed and organised as to be best prepared to meet the most probable attack, it will be convenient to discuss each separately and in the above order.

FORTRESSES AT HOME.

DEFENCE AGAINST TORPEDO-BOAT RAIDS.

In order to divorce our thoughts from preconceived notions and existing works, it will be well, for the sake of discussion, to take an ideal case of a harbour with a narrow entrance to be defended against this class of attack, and to examine the various means of defence which might be available, and the most suitable organisation. We may then be better able to see in what way existing works and schemes of defence might be improved.

BOOMS.

A boom or obstruction of some kind across the channel is essential if we are to be at all sure of preventing torpedo-boats getting through.

No matter how good the gun defence and the lighting arrangements, if the boats only attack in sufficient numbers some are certain to get past, and, if unimpeded, could run clear into the harbour.

It scarcely comes into the subject of this article to discuss the various forms of booms, but the ones now in use should, we think, be quite good enough to achieve their purpose of at all events impeding or delaying torpedo boats.

The position of the boom necessarily affects the position of the guns and lights, and though it would usually be placed at the narrowest part of the entrance, other considerations might make it necessary to put it elsewhere and to employ a longer boom, or narrow the channel by breakwaters or the erection of "dolphins," permanently closing part of the shallower waters.

MINES.

Mines are not as a rule employed in defence against torpedo-boats, they have other and more important work to do in acting as a deterrent to the attack of larger ships, and should not be fired on the chance of sinking such a small and fast moving target as a torpedo-boat, thus leaving a blank in the mine field. But there is one contingency which we must keep in view and which may make the employment of mines in narrow waters very necessary in the near future, and that is the possibility of being attacked by submarine torpedo-boats. Such an attack could not be repelled by gun fire, a boom, unless specially constructed, would be of little use in preventing their entering a harbour, and mines may prove to be the best weapon of defence against them.

ELECTRIC LIGHTS.

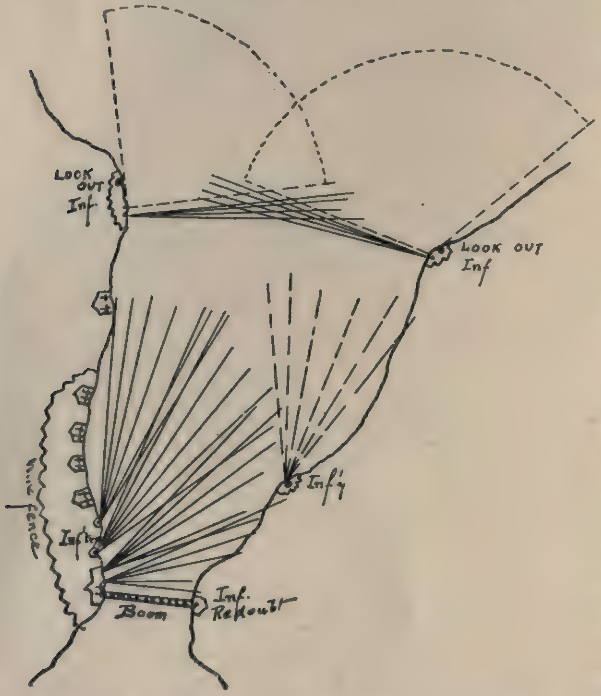
The arrangement of the electric lights is one of the most important factors in a successful defence and one of the most difficult to decide upon. The present recognised method is to have an illuminated area in front of the boom, and advanced lights termed "sentry beams" and "searchlights" through which boats must pass before they reach the narrower waters near the boom. All things considered, this appears the best arrangement, as timely warning of the approach of boats can be given, and they come under close range fire as soon as they enter the illuminated area.

The scheme so often adopted of having guns and lights on both sides of the channel is, however, not always satisfactory, though sometimes necessary owing to the breadth of the entrance.

In the ideal case under consideration, it would be better to keep all the lights as far as possible on one side, thus giving a complete belt of light in front of the boom without any of the beams crossing each other. The most advanced of these beams should be able to light up the water close to the shore to prevent any chance of "creeping," and if it were found that the lights would not illuminate the far shore sufficiently clearly, a beam might be placed as shown by dotted lines in the sketch on page 324, to light up that side of the entrance.

The beam nearest the boom should be capable of being turned upon it, to light it up in case of an attempt at destruction, but as a rule the boom should be left in darkness.

By such an arrangement of the lights, besides doing away with crossing, we make it more difficult for an approaching boat to judge where the entrance to the harbour actually lies, facilitate the protection of the lights against an attempt at destruction by small landing parties and enable the generating plant to be kept in one place.



TYPICAL DEFENCE AGAINST TORPEDO-BOAT RAID.

In the case of sentry beams, however, this will not often be feasible, and we shall have lights on either side. As these are to enable timely warning to be given of the approach of boats, they should be placed as far out as possible. They should always be duplicated in case of a breakdown, or of its being necessary to change carbons, and the spare lights used to search the water outside the sentry beams.

All electric lights should be situated sufficiently close to the water to prevent there being much "dead water." Their protection against an enemy's fire is now practically assured by the introduction of the "parabola ellipse" reflector, which enables them to be placed behind armour in which only a small aperture 3 ft. high and 2½ to 8 in. wide, according to the angle of divergence, is necessary.

The siting of the fixed beams depends on the sites selected for guns and mine fields. They may exist for both, or for guns alone. Each pair of lights should, if possible, be rather on the inner side of the batteries for which it is intended, and on a slightly lower level, as previously stated, as objects in the beam are more plainly visible from above it.

As regards the beams themselves, it cannot be too strongly urged that they should combine power with dispersion; the former is sometimes sacrificed to the latter. Rather than sacrifice power, the number of lights should be increased. The lights should be sufficient in number, or their power and dispersion increased sufficiently, to allow the whole channel within effective range of the guns to be fully illuminated. Otherwise the full fire effect is not obtained. This is merely a matter of calculation, and the nearer the channel, the greater the dispersion required. For instance, suppose a battery of 12-pounders with its mean line of fire at right angles to a channel 800 yards distant, and down the centre of a pair of fixed beams with the usual 60° dispersion. A vessel on entering and leaving the beam will only be 900 yards from the battery, which, given light, could open fire with effect at 1,200 to 1,500 yards.

As far as possible on the outer side of the defences should be a look-out post, in direct communication with all quick-firing batteries, and near it powerful sentry beams which should be solely employed in searching the approaches, with a view to giving as early an alarm as possible of any attack to the defence.

After the attacking torpedo vessels had passed the look-out post, these beams would probably have to be used as an exceptional case to aid the fire of the heavy guns of the outer batteries in keeping the covering fleet at a distance.

GUNS AND WORKS.

The 12-pounder quick-firer is an excellent all-round gun for this class of defence; it is sufficiently powerful to sink a boat if it hits it, and has a good rate of fire.

It is, however, quite possible that an enemy would send in some larger or heavier vessel with the object of smashing the boom to clear the way for the torpedo-boats, and although submarine mines might succeed in stopping or sinking it, it is necessary to include in the defence, some heavier guns capable of dealing with such a case. A group of two 6-in. Mark VII. guns situated well away from the boom should answer the purpose.

All the guns should be placed on one side of the entrance when possible. This would simplify the lighting arrangements as before explained, enable an effective scheme for the distribution of fire to be devised, facilitate the rapid transmission of warning or orders, and the protection of the guns from a land attack, and do away with all chances of the bad moral effect which would result from shots from a battery on one side of the channel ricochetting into one on the other side, a contingency which has now to be met by "stopping" the guns, thus limiting their effective arc of fire.

Two is the greatest number of guns which can be efficiently looked after by one officer, who, besides having to direct his fire, must attend to the supply of ammunition and the replacement of casualties, etc.; all guns should therefore be arranged in groups of two, each group being perfectly self-contained and independent of all others.

These groups should be at least 50 to 100 yards apart to prevent confusion of orders and the effects of "blast" and "flash" on the laying of other guns.

The guns should be placed above and in front of the lights, with the exception of one group for the close defence of the boom. The best height above water at which they should be placed must, to a great extent, depend upon the conformation and nature of the coast line. The flatter the trajectory the better should be the chance of hitting at close range, and for this reason they should be placed as close to the water as possible; but, on the other hand, it is necessary for the efficient use of auto-sights, to have a certain amount of height, and we can say that about 40 ft. above the sea should be their normal position, which will give accuracy with auto-sights up to about 1,600 yards.

The high siting of guns may sometimes give what is called "dead water," upon which they cannot be depressed if the banks are steep and deep water comes close to the shore. In such a case it will be necessary to have one group close to the water's edge for the special purpose of covering this "dead water" area and preventing "creeping" by torpedo-boats.

As the batteries are not intended to withstand a a heavy fire, they will not require any great amount of protection, and as they will be used chiefly at night, they should be of very simple construction. There should be no lifts from the magazines to the gun floor, and steps should be avoided as much as possible. Ample recesses should be built around the emplacements to hold all the ammunition likely to be required in action. Special attention should be paid to the sleeping accommodation for the detachments, as if they do not get good rest during the day they cannot be alert and up to the strain of continuous night work. There should also be small shelters by each gun, so that a few men may always be in readiness to open fire the moment the alarm is given.

All batteries should have a slight infantry parapet in rear and should be entirely surrounded by an unclimbable fence to prevent any chance of their being rushed. If commanded by high ground within about 1,800 yards which might be occupied by a landing party, they should have a parados or a high wooden palisade to screen the detachments from rifle bullets. They should, also, if necessary, be made with a strong traverse on the sea flank, to protect them from enfilade fire by a ship assisting the torpedo-boats. This traverse would also, to a certain extent, prevent "blast" from interfering with other groups.

ORGANISATION.

As a torpedo-boat raid is the one we must be best prepared to meet, and as it may take place before mobilisation has been completed, it is important that everything should be done in peace time to keep the defence ready for immediate action.

To obtain absolute efficiency, the defence against torpedo-boats should be considered quite separately in all general schemes of defence. All the light quick-firing guns and the electric lights should be controlled by one officer, who would organise the defence in peace time, train the men in their work, and command them in war. He should have under his orders at peace manning, and on war mobilisation, not only the R.G.A. to work the guns, and the R.E. to work the lights, but also any infantry told off for the special protection of lights and batteries, and men told off to lay and work the boom.

It is more than probable that small parties will land and attempt to destroy the lights or silence the guns in conjunction with the boat attack. The protection of landing places, and the action of the infantry comes more under the general defence of the fortress, but, as, in spite of all precautions, a few men may creep through unobserved, the "torpedo-boat defence" must possess an independent organisation for its own protection at close quarters. Here again is an advantage of having all the guns and lights possible on one side.

The batteries should be able to protect themselves by carbine or machine-gun fire; the electric light emplacements and engine rooms, etc., should be surrounded by parapets and unclimbable fences, and have a small guard of infantry, and possibly Maxim guns if at all isolated; the boom should be protected by a small work or loopholed wall at each end, the men in charge of the boom being reinforced, if necessary, by a few rifles (*see diagram*).

FORTRESSES AND COALING STATIONS ABROAD.

These, if within range of a torpedo boat raid, are as liable to this form of attack as our home fortresses, and the foregoing remarks as regards the preparation to meet it apply equally.

But they must also be prepared for a raid on a much larger scale, especially the smaller and more distant and isolated coaling stations, and should be armed and organised accordingly.

Mines and Brennan torpedoes are likely to play a very important part in the defence and in preventing ships coming in to close range, but space does not allow a discussion of their merits as we are in this essay more particularly concerned with the artillery defence.

ELECTRIC LIGHTS.

These must, of course, be established for the protection of all defended harbours at night, whether the harbour be exposed to a regular torpedo-boat raid or not, as an enemy may send in boats and pinnaces during dark to reconnoitre, to countermine, or for other purposes.

The general remarks on the placing of lights already under the heading "Fortresses at Home" hold good, except that instead of having a lighted area in front of a boom, the inner lights would be arranged to light up the mine fields.

The outer searchlights would have an important work to do in preventing an enemy's ship getting in close to the works unobserved, for, although it is agreed by most authorities that ships are unlikely to attack at night, it is nevertheless extremely probable that they will make use of the darkness to get in as near as possible, in order to open fire on the batteries at close range at dawn, instead of steaming in, in broad daylight, exposed for 8,000 yards or so to a far more accurate fire than any they can return.

Existing lights would appear unequal to lighting up even large vessels at anything over 2,000 to 3,000 yards except under very favourable conditions and it may, in some cases, be found advantageous to send out vessels fitted with searchlights to assist the defenders in discovering the approach of ships.

GUNS.

We do not require many guns in coast batteries, but what we have should be the very best and highest velocity available. Modern ships are very strongly armoured, and unless we can penetrate their armour we cannot effectually cripple them, although by a rapid fire at the upper structures we may make them draw off.

Quick firing is very important, especially with the lighter guns, which may have but a small and fast moving target exposed for a very short time, or may be opposed to the lighter guns of ships at close range, when speed in firing will be essential.

With the heavier guns, a rapid rate of fire may also be necessary. It is the opinion of many naval officers that if ships engage forts, they will attempt to steam in at full speed to close range and then anchor, when the larger number of lighter guns they carry, and their better armour protection, may give them an advantage over the open shore batteries, which will be overwhelmed by a superior volume of rapid fire.

It may therefore be imperative for batteries to try and stop ships before they can get to close range, and fire will have to be opened at about 10,000 yards and gradually increased in rapidity as the range shortens and accurate laying with auto-sights, with which presumably all modern guns will be fitted, becomes possible.

To enable an accurate fire to be opened at these extreme ranges the guns must have a high initial velocity.

The projectiles from the heaviest guns should be capable of penetrating the belt armour of modern vessels at, at least, 2,000 yards, and those from medium guns should be able to pierce the armour of, and destroy, the secondary armament.

WORKS.

The introduction of high velocity guns and high explosive shells on ships sealed the doom of the elaborate granite forts, tightly packed with muzzle loaders, which figured so prominently in our coast defences, and the tendency now is to keep to works of simple trace, made as inconspicuous as possible, and armed with a few good guns.

Owing to the long range now obtainable from guns, the batteries need no longer be kept close to the water's edge, but can, if necessary, be withdrawn and placed on higher ground.

The adoption of automatic sights has made it important that guns should be mounted as much above the sea as possible, and where no high ground is available, an artificial mound is raised, or the old forts are made use of as a substructure on the top of which modern ordnance can be placed.

Besides the greater accuracy in laying, range-finding, and observation, obtainable from high sites, they possess every advantage for the heavier guns; these become less liable to be hit by an enemy's projectiles, as ships cannot come in to very close range or their shell would pass over the batteries without doing damage, and at long range their fire is not likely to be very effective.

At any but very close ranges, coast defence guns possess an enormous advantage over ships, owing to their firing from a stable platform.

The latest works built afford, for the most part, good protection to the guns and detachments, but we still do not appear to recognise the importance of protecting the executive officers and the communications. One sometimes sees the battery commander, and his range-finders with practically no cover at all, telephone wires exposed, and dials in the open where they could not remain five minutes under fire.

On board ship the executive officer is in an armoured conning tower, sometimes as strongly armoured as any part of the ship, his means of communication are close by him, and the wires, etc., are led away in armoured tubes.

Are not these precautions equally necessary on shore? Although the B.C. and his staff are nowadays no longer so indispensable as heretofore, and the guns can, if necessary, be fought just as well without them at close range, the effective direction of fire in the preliminary stages of an engagement still depends entirely upon them, and as long as they are found to be necessary they should be protected.

We therefore think that the B.C.'s post should consist of an armoured emplacement or cupola placed in the most commanding position in rear of the centre of his guns, where he could see what was going on, observe his fire and pass his orders without delay. His D.R.F. instruments should be close by him, as it is no longer necessary to place them on the flanks, owing to the introduction of smokeless powder; the instruments themselves should be of an "overhead type, in order that they and the detachment working them may be safe. All telephone wires, speaking tubes, etc., should run direct into and from the B.C.'s post, and when not buried at least a yard deep should be carried in steel pipes; all range indicator dials of the present clock-faced pattern and "figures" should be relegated to the scrap heap, and reliable electric range dials and order dials introduced, so that the whole of the communications may be under cover.

Another point requiring consideration when constructing new works, is the nature of ground used on the outer slopes. This, if of a crumbly nature, causes clouds of dust to obscure the view of the guns even at peace practice, and when thrown about by the bursting of an enemy's high explosive shell, might make it quite impossible to carry on direct fire at all; if shingly, it may make things quite uncomfortable for the gun numbers in action, though this would be the lesser of the two evils. A heavy soil well bound together by surface roots or grass would appear the most suitable for the purpose, but would rarely be available at foreign stations.

The drill book recognises that at close range, owing to dust and smoke from the enemy's bursting shell, it may be impossible to lay the guns over the sights, and to meet this eventuality it has been found necessary to retain position finders, placed some distance away from the batteries, so that the guns may be fought by Case III. from under cover. The cells for these instruments will require very careful screening, more so than is sometimes the case at present, in order that an enemy may be unable to ascertain their position even at a short distance, as otherwise he will no doubt do what he can to render them untenable.

The ammunition supply to guns is a very important detail to attend to. It is pretty well recognised that it would, in these days of rapid fire, be inadvisable to attempt to supply guns in action direct from the magazines by lifts, but that all the ammunition likely to be required will have to be previously brought up and placed handy in recesses near the guns. It is therefore necessary that these recesses should afford ample room for the storage of a plentiful supply, be easily get-at-able, and be well protected from an enemy's fire.

Batteries should be well defended on the land side, for whatever the action of the ships, there can be no doubt that if the destruction or capture of the works is aimed at, landing parties will play a very prominent part, and their success or failure will probably decide the ultimate result of the raid. Every battery should be a self-contained fortress, if at all isolated, and its safety should not depend entirely upon the advanced infantry; it should have a good infantry parapet, be surrounded by unclimbable fences, entanglements, abattis, and other obstacles, have a clear field of fire, defiladed by a parados or by traverses if the interior or the guns can be commanded by high ground, and in fact be made as impregnable as modern fortification can make it.

ORGANISATION.

The reduction of the number and types of guns used, and the introduction of auto-sights will very greatly affect the organisation for defence.

This must be as simple as possible and the main object kept in view must be decentralisation of responsibility and the encouragement of individual initiative.

There must be one supreme head of the defences on both the sea and land fronts, but section commanders and fire commanders should be reduced to a minimum, and battery and gun group commanders should be prepared to act upon their own responsibility without waiting for orders from higher authority, for, under modern conditions, there will be little time to spare between the sighting of an enemy and the opening of fire. All orders as to selection of targets and distribution of fire should be arranged in peace time, and frequently rehearsed, so that when the attack takes place each individual may understand exactly what is required of him and act without hesitation.

In any case the higher commands must gradually become of less importance as ships approach the batteries, until, when these are within effective auto-sight range, we may expect to find each gun acting independently and correcting its own fire. It is absolutely impossible for a B.C. or G.G.C. to make himself heard, or to pass orders, if three or four quick-firing guns are firing with any rapidity, and it is to be hoped that this may before long be recognised by our drill books, and that our men may be trained in the observation and correction of fire of each gun by its gun captain and layer whenever auto-sights are used. This system has already been tried at practice and found to work very well; it will, however, entail a much higher standard of intelligence on the part of our N.C.O.'s and men, more care in the selection of gun-layers, and a thorough knowledge of the guns and mounting in use.

GUNNERS.

Gunners should be given that work for which they are best suited physically. Quick-firing gun drill requires men with a quick, active physique, not necessarily big men, but hard, wiry men of middle weight, who can move quickly and can last. Fat and clumsy men are utterly out of place. Selection of men of suitable physique has much to do with the maintenance of a high rate of fire.

When gunners are first called upon to defeat an enemy's raid, with the alternative, in the event of failure, of perhaps millions of dollars worth of *materiel* lost to the nation, the all important man will be the gun-layer. He will be at his gun waiting, see a torpedo vessel enter the beam perhaps at over 20 knots an hour, and have to stop that boat while it is under his fire, perhaps for one or two minutes only, if that in some cases. What conditions can be more calculated to upset a man's nerves, to make him in fact lay his gun less accurately than usual? Some men have a natural genius for gun laying, are always sure of themselves, have a marvellous control over elevating and traversing numbers, and always keep cool. We see it in the tests to which we put them in peace time, when they consistently lay a gun accurately in about half the time the average layer takes. Yet we let these men go when their time is up. We make no more effort to retain them than any ordinary man.

Every gun has its own peculiarities, and it is just as necessary for a detachment to know their gun as for a sportsman to know his, or an infantryman his rifle. As at stations abroad, the men required to work the guns are, or ought to be, always on the spot, it could be easily arranged to have a number of them told off to each gun and to get them to look upon it as their own particular weapon, much as is done on board ship; they should be responsible for keeping it cleaned and in working order, for mounting and dismounting it when necessary, and should always keep to it at drill and use it at practice and in action.

HARBOURS OF REFUGE.

The defence of these calls for few further remarks. Most of what has already been said under the previous headings applies to some extent in this case.

Although it will rarely be feasible or desirable to close the entrance with a boom, there must be a good proportion of light quick-firing guns in the armament, and electric lights must be provided, in order to prevent raids by small boats during dark. The defence might be greatly assisted by a line of anchored barges or pontoons carrying quick-firing guns, if the entrance is at all broad, an illuminated area being established just in front of these, but any form of floating defence should be avoided if possible as it is likely to interfere with the freedom of fire of the land guns.

If larger vessels attack they will probably be cruisers or "commerce destroyers," and to meet these an armament of 6-in. guns should, as a rule, be good enough, with perhaps a few heavier guns to deal with a possible attack by armoured cruisers or battle ships, and keep them out of bombarding range of the shipping.

These defences are not intended to stand a determined attack, and there is no necessity for overdoing their armament, but the few guns provided must be the very best.

An attack by a landing party being extremely probable, as some harbours of refuge are somewhat isolated, and as a large force may not be available for their protection, the batteries, while made safe from a sudden rush by means of the usual parapet and unclimbable fence, must be further guarded by small infantry redoubts occupying any high ground within range of the rear of the batteries, and which might be occupied by the enemy with a view to keeping down the fire of the guns while the attack on the shipping in harbour is made. The landing places should also be guarded by small redoubts, which might with advantage be provided with one or two 4·7-in. guns able to fire shrapnel shell at any boats attempting to land men.

No elaborate organisation or chain of command is necessary, as, if attacked, there will be little doubt about what to do and how to do it, provided definite orders and instructions have been issued beforehand.

The garrison should consist in great part of local Militia and Volunteers, who will take a personal interest in the defence of their port and homes, will know the coast and surrounding country, and can be trained in peace at the work they will carry out in war, so that on mobilisation there will be no delay, and the port will be placed in an efficient state of defence against raid before the declaration of war.

FRENCH ENGINEERING PROBLEMS.

BY EDWARD CONNER.

TWELVE months have elapsed since deputy Aimond presented his very able and comprehensive report upon the actual conditions of engineering in France, as compared with that in other countries. Disheartening as this document was at the time, it was entirely free from exaggeration. The state of engineering in France was shown to be gloomy indeed, the cause of the prevailing industrial depression being attributed partly to want of capital urgently required to carry on modern improvements, and partly to the lack of energy displayed by his countrymen, the majority of whom had not yet become convinced of the imperativeness of looking ahead, and of visiting neighbouring countries for the purpose of acquiring new ideas.

It is indeed a very great pity that engineering France has so little capital at its command, and that so many excellent and practical suggestions have to remain inert in consequence. Not a day passes but canals, rivers, and harbours throughout the country require something done to them, because found inadequate for the commercial development of the country. As compared with the neighbouring continental states, France cannot show much work done, though she has indulged in a great deal of patchwork, so hampered has she been by financial difficulties.

In the course of an engineering tour through France, weak points seem to crop up here, there, and everywhere. To begin with, the northern section, which is, indeed, a very important artery, one is surprised to find that the metallurgic region of Eastern France is in no way connected with the North Sea; in other words, this very wealthy part of France is absolutely dependent upon Antwerp. How serious this is from a maritime point of view can be easily imagined when it is found that the same region is equally dependent upon Germany as regards inland transport. It will be easily seen how urgent it is for the French Government to construct as quickly as possible a navigable way, which will render France independent of those neighbouring States, and enable her to convey her large consignments of coals from the Pas-de-Calais to other parts of Eastern France through French territory. A project of this kind has been under consideration for more than two years; French political disturbances, and almost incessant changes of Government, have, however, prevented the scheme from reaching maturity.

The two canals in question, which will, it is to be hoped, before many more years be completed, are the Chiers, connecting Longwy and the Meuse, and the Canal de la Meuse, which will be made to join the Escault. When these two canals are inaugurated the French engineering world will have every cause to warmly congratulate itself. That the industrious inhabitants of the Pas-de-Calais, and Nord departments should display impatience at the delay on the part of the Government to provide them with such outlets is only natural; no one knows better than they do how beneficial and indispensable these two highways will prove. Let it be said, *en passant*, that when terminated, communication between the North of France and Paris, by the already constructed canal of St. Quentin, will increase considerably.

It is with unfeigned interest that we turn to the Valley of the Loire, the most fertile spot in Western France. The efforts made some years since to transform that majestic river—the Loire—into a navigable stream, have not yet been crowned with success. Such a task is in any case "freighted" with difficulties, which time only can overcome. The Government, we are aware, is willing to experiment none the less, and deal with the vexatious problem by degrees. That part of the Loire situated between Nantes and Angers will be the first to receive the attention of engineers; were that small section to at last become navigable, it would alone be worth its weight in gold, as it would afford a *débouché* to minor tributaries, important in their way, such as the Loir, la Sarthe, and the Mayenne.

Proportionately speaking, Nantes has proved the most prosperous of its kind of late years to France; no other sea-port having been able to report progress in so little time. Official statistics inform us that its tonnage, from being 354,000 tons in 1890, rose to 1,176,000 tons in the space of nine years—almost a record, so far as French shipping is concerned. This phenomenal success was solely due to the construction of the maritime canal from La Martinère to Carnet. The moral of this once more indicates that the best way to create commercial animation in any growing centre, however small, is to pave the way in advance, rather than wait until increasing demands of traffic make it imperative to start such operations.

The Bassin du Rhône is also another important hive of industry which awaits engineering development. The French maritime world is anxiously looking forward to the day when Marseilles will be able to hold its own against its rival—Genoa; engineers have stated that this could easily be done, and at little cost moreover by establishing a direct connection between Marseilles and the Rhône, which flows through a wealthy district. After all, the river Rhône is really the *tête de ligne* or starting point, and very proud are the local inhabitants of the fact. Unfortunately, the Government regrets for the present to be unable to create such a link, though it is occupied with completing projects voted as far back as 1868; these schemes comprise the connection of the Rhône, *via* the north, to the Loire; and the latter in a southernly direction to Marseilles and Cette. Other plans must wait. No objection is raised to this, provided the State does not overlook the joining of Marseilles to the Rhône—a project which must be achieved some day, it having become an undisputed commercial necessity.

All the money that the Government can conveniently devote to maritime schemes it does unhesitatingly, as will be seen. Millions are actually being expended on the principal sea-ports of the country. Dunkirk is undergoing a complete change; the mouth of the harbour is being deepened and enlarged in a general sense of the word; several new ship-yards are being built, to say nothing of other necessary improvements the total cost being estimated at over 30 millions of francs. The same remark applies to Dieppe, on which port 11 millions of francs more will be expended. Another 20 millions of francs have been voted for bringing Havre up to modern requirements; 23 other millions are to be spent on Nantes for the same reason. The aim in view in each case being to enable vessels of a larger tonnage to enter the harbour.

The contemplated ameliorations in the port of Bordeaux will entail an expenditure of at least 14 millions of francs. Boulogne-sur-mer, Cette, Bayonne, etc., will also be overhauled in due time, regardless of expense.

Enormous as these various outlays appear, they have been as economically studied as possible; the nation insists that the State should continue to spend large sums every year in order to avert commercial decline. France is still a first-class power, and, as such, must either follow the lead of other nations on an equal footing with herself, or collapse.

FAMOUS TECHNICAL INSTITUTIONS.

III.—THE BIRMINGHAM UNIVERSITY.

BY

C. ALFRED SMITH, B.Sc., A.M.I.E.E.

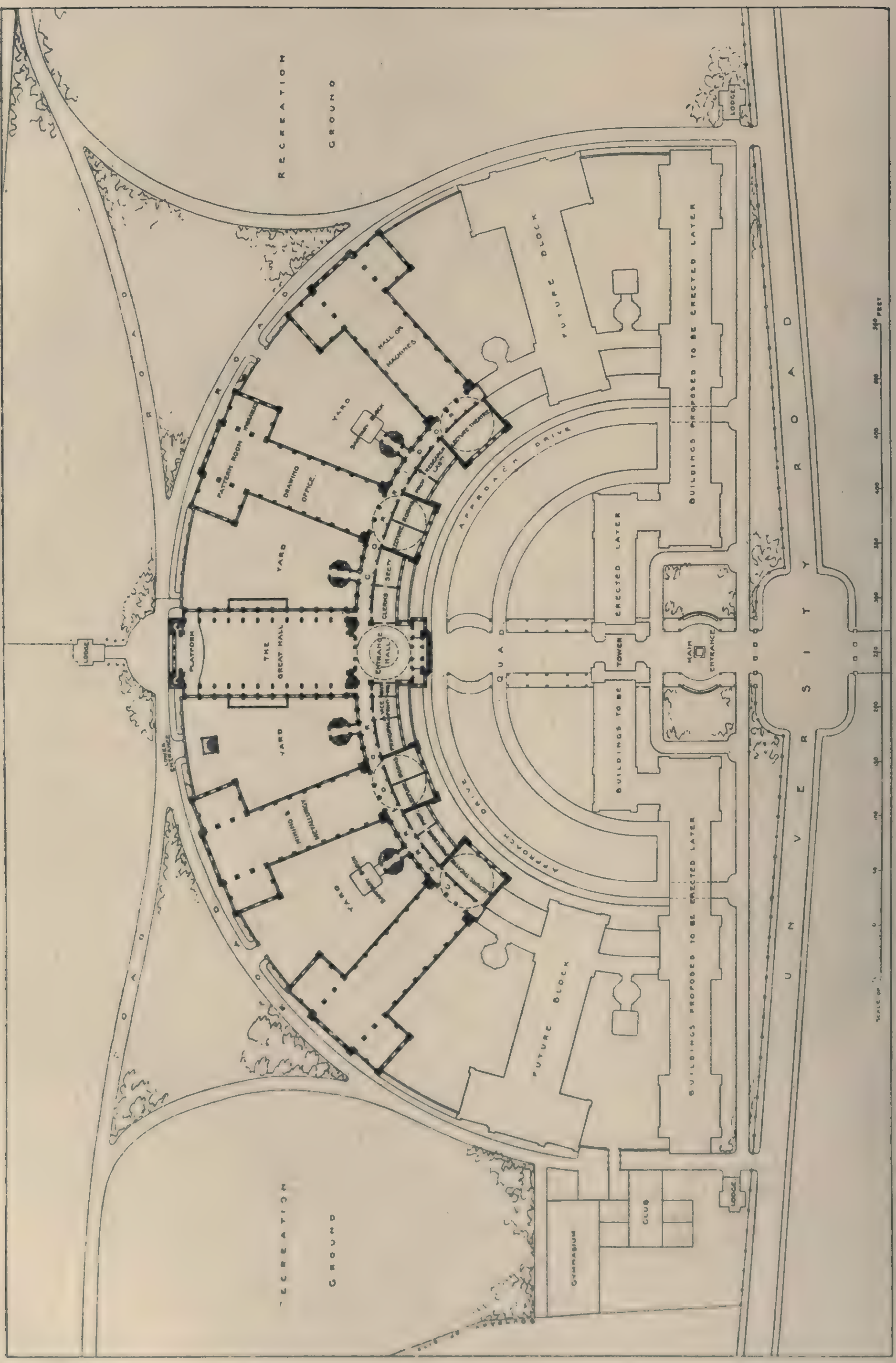
The fourth of a series of articles describing prominent technical institutions at home and abroad. The Massachusetts Institute of Technology was dealt with in the January number of PAGE'S MAGAZINE, and in the following issue Mr. C. A. Smith commenced the description of the Birmingham University, which is now concluded. The February instalment included details of the power station; in the March issue the author turned to the foundry and forge and the huge laboratories and workshops known as the main buildings. In the present article he discusses the metallurgical, smelting and furnace section. For many of the illustrations of the Birmingham University we are indebted to the Editorial Board of the "University Engineering Journal."—ED.

PART III.

THE METALLURGICAL SMELTING AND FURNACE SECTION.

COMMENCED a year after the power station, this structure will now be complete in the course of a few weeks. This building, which is 125 ft. long, 50 ft. wide and 28 ft. high to the roof principles, is lighted at the top, and is well ventilated by a top louvre and cross ventilation. It is divided into four shops, the two large ones being each 50 ft. square, and the two smaller ones 25 ft. square. In the former the dividing walls do not reach to the roof and a good circulation of air is therefore assured. One of the large shops is exclusively for steel melting, the other for treating ores of gold, silver, copper, lead and any other non-ferreous metals. For the steel melting there is a two-ton new form of Siemen's regenerative furnace, built by Frederick Siemens, of London, with the necessary gas producer, lift and casting pit, the furnace being also arranged for experimental work with Mond gas from the power station. There is ample room for further appliances which will be added later. In the non-ferreous smelting house, ranged along one side of the room, there are a circular water jacket cupola blast furnace for melting copper and lead ores, an English cupellation furnace, a Brukner revolving calciner, and a roasting furnace for dealing with various kinds of ores. Along the other side of this room are placed the storage, leaching, and settling tanks and a lead-lined chlorination barrel for the wet treatment of gold ores. The whole of this apparatus is designed and supplied by Messrs. Fraser and Chalmers, London. Of the two small shops, one is ultimately to be devoted exclusively to that new branch of applied science which is making such rapid progress—electric smelting—while the other is to be a small experimental steel and brass foundry for pot furnace work. Four holes will be provided in this foundry, two for steel and two for copper alloys. This portion of the equipment is being provided by the Morgan Crucible Company, of Battersea, London. A special feature of the design of this building is an outside flue 4 ft. 6 in. high, inside measure, which leads from the smelting plant to a stack which will serve for all the smelting work. It is arranged for the collection of flue dust and the recovery of precious metals therefrom, and is specially constructed so that the students will be able to thoroughly inspect it, a detail which is seldom taken into consideration in ordinary work, but which is very desirable. This building is believed to be a more lofty, better lighted, and more complete and compact one than at present exists anywhere for metallurgical instruction (not even excepting the great American universities). It will be ready for the students by July 1st next, when it is proposed to arrange a summer metallurgical school lasting for one month. This section will be used in connection with the regular teaching during the coming session.

When facing the great hall, the building which is on the left hand is to be used for mining and metallurgy. Students in either of these branches of applied science will also do some work in the subject in which they do not intend to specialise, *i.e.*, the mining students will take special work in metallurgy and *vice versâ*. The lower ground floor of the T-shaped portion of the building is for the mining department, while the main ground floor is for the metallurgical section, the professor in charge of which is a man famous for his discovery of the influence of silicon on cast-iron—Professor Thomas Turner. Although the general outlines are decided upon, so rapid are the new inventions in this work that the Professor is keeping an open mind concerning many of the details, and is arranging his plans so that these can be changed, should he deem it advisable, when the buildings are ready for the equipment. There will be separate and special laboratories for pyrometry; the microscopic examination of metals; and electro-metallurgy—especially with a view to electrolytic work, of which so great a quantity is done in the district. There is a separate balance room which will be large, airy,



PLAN OF THE BIRMINGHAM UNIVERSITY.

From the "Building News."

and well lighted. At the end of the T portion of the laboratory is the machinery required for the preparation and sampling of metals and ores, and also the furnace room for dry assaying and similar purposes, so that all the noise and fumes are well away from the laboratories. The whole of the practical work of this department is on one floor, which (contrary to that in any of the existing universities in America) is above the ground. In the past, cellars have been invariably used out there for housing those engaged in the learning of this science. This block is, however, well lighted on three sides, the windows commanding considerable views of the university grounds and neighbourhood. The large elementary laboratory is also to be provided with additional top light. There will be in this block a large museum extending round the whole length of the centre part of the T with specimens and samples. Professor Turner will be able to accommodate fifty ordinary and ten research students in any one year, and since the course extends over three years this means that 180 students can take the metallurgical course.

THE MINING DEPARTMENT.

In this department, which has been reconstructed recently, and is under the able direction of Professor Redmayne, the instruction will include both branches of mining—coal and metalliferous, as well as surveying. The work done will be of as practical a nature as possible. For this purpose a model coal mine is being constructed, covering nearly an acre of ground. In this mine underground surveying, the manner of connecting underground to surface surveys, the laws governing the ventilation of mines, and systems of ventilating and modes of working collieries will be taught. Method of haulage, operated by gravitation and electrical power, will be in operation in the mine. In addition to this all kinds of safety lamps, mining tools, drilling and boring apparatus, coal-cutting machines, winding and hauling ropes, coal-tubs, etc., will be represented, and will be in constant use by the student for sketching, handling, and experimenting with.

Although the essential mining industry of the Midlands is coal mining, there will be for the benefit of students from the colonies, or those who intend practising metal-mining, a fully equipped metal-mining laboratory, one of largest in the world. This is so designed that all of the processes of treatment of the ore will work, as in actual practice, by gravitation. For this purpose the floor is built on three different levels. On the highest is the crushing and stamping machinery; on the intermediate, sizing and dressing, the settling pans and leaching tubs; and on the lowest the apparatus for the mechanical treatment of the tailings, which include a frue, vanner, a buddle and a wilfley table.

The water, which will be used over and over again, will be kept at a constant pressure by an elevated tank and regulators. This laboratory will be capable of treating ores of tin, copper, silver and gold, and some of the minor metals. The operations demonstrated will be those of coarse crushing, fine crushing, sizing, hydraulic classification, jigging, slime-washing, electro-magnetic separation and lixiviation.

The museum, a large and spacious room, is so situated that the students will have to pass through it on their way to the draughting and other classrooms; the object aimed at being to make them familiar with the contents so that daily object lessons may be presented to their gaze. It will contain, amongst other things, large working models of several classes of mines, parts of actual mining machinery or appliances, such as air-compressing machinery, mining tools, blasting apparatus, ores, and ore dressing, products from different mines in various countries, samples of coals and other fuel from the Midlands and various parts of the world.

For plotting mining and other surveys, levellings, etc., and instruction in mining drawing generally, there is a large draughting room. In the coal-mining laboratory many operations related to coal mining will be practically demonstrated, as, for instance, the working of machine drills, coal-cutting machines, the construction and testing of safety lamps, manner of testing the safety of explosives in gaseous mixtures and coal dust on a small scale, etc., etc. The departmental library, when completed, should form a centralising point not only for local but world-wide mining literature.

In the coal-mining research laboratory, advanced students will carry on the testing of the relative values of fuel, etc., and other research work. There are also two class instruction rooms for advanced students, the one containing printing and photographic apparatus, the other the surveying instruments in use.

The heads of the three great departments, engineering, mining and metallurgy, are men who had already won reputations as experts in their own particular subjects before they went to Birmingham; it is obvious to the most casual observer that they have greatly enhanced this by their unique record chronicled in these articles.

FOUNDRY COSTS: THEIR ANALYSIS AND REDUCTION.

BY HENRY HESS.

Mr. Hess describes a simple system of plotting cost records and methods of analysis based on comparison with ideal conditions.—ED.

IN order to economically manage a foundry it is necessary to know accurately the various elements of expenditure, and, having these, to analyse properly their relation to one another and to the product. The manager is then in a position to check at once any rising tendency of the costs or to bring about a reduction, as the analysis points out an opportunity. No doubt, all of this can be, has been, and is being done successfully to-day by many a foundryman to the entire welfare of the business without any conscious or formal analysis or detail accounting. There are many managers of the old school who, through personal experience, a high order of native talent, and close touch with every detail, get along without other aids. But in these days of large and growing concerns, it is neither advisable nor safe to rely utterly on one man, no matter how capable, nor yet to the best interests of all concerned to burden the higher officials with the infinite detail work needed to get into sufficiently close personal touch with the entire working routine.

It is quite possible so to present the vital elements of cost that the managing head can at once grasp all salient features, see whether cost is stationary or not, and determine where effort must be applied to check a rise or bring about a reduction. The necessary work forming the basis of analysis can be readily performed by a very ordinary grade of shop clerk, once the routine has been fixed.

THE ELEMENTS OF COST.

To start with, all of the elements of cost must be enumerated. It is well also to assign to each element a value, not so much with the idea that this value is absolutely correct, but rather to have some basis of comparison; experience may be relied upon to gradually bring about correct values. The figures given hereafter are to be taken as having merely an illustrative value; no attempt is made to provide a record of actual or proper costs.

In illustration, the elements of cost are divided among a few main heads as follows, it being understood that for actual work a subdivision more in detail must be used; to enumerate them fully is outside the province of this article, in which it is intended merely to present in general outlines a successfully used plan:—

(*a*) General expense.
(*b*) Fixed salaries.
(*d*) Power.
(*e*) Miscellaneous materials.
(*f*) Labour.
(*g*) Pig and other charging metal.
(*h*) Smelting material.
(*j*) Light.
(*k*) Recovered material.

The collating of the actual amounts of the various items as incurred is best done weekly rather than monthly or at other long intervals, as that will permit the recognition of a defect in time to trace it correctly to its cause and to apply a remedy. Should a longer interval be determined on, that should be four-weekly rather than monthly, in order to avoid the disturbing effect of the varying number of working days in different months, and also because it fits in better with the weekly pay accounts. Such charges as are based on a monthly rate can very readily be converted into an annual and from that to a weekly rate.

Apportionment of the various elements of cost to main divisions is made in accordance with readily apparent principles:—

(*a*) General expense: Depreciation and interest charges.

(*b*) Fixed salaries: All salaries to persons having a fairly certain tenure of office; salaries to minor clerks that are likely to vary in amount should be entered under labour.

(*d*) Power: All charges directly connected with the power plant.

(*e*) Miscellaneous materials: Sand, flour, chaplets, wire, molders' implements, etc.; in fact, all materials not accounted for under heads (*g*) and (*h*).

(*f*) Labour: All payments made to workmen and other persons. Includes all pay not taken care of under head (*b*).

(*g*) Charging metal: Everything charged into the cupola, except fuel and flux; also all "medicine," whether added in the cupola or ladle.

NOTE.—For purposes of comparative analysis these materials should be rated at fixed values, although they will be purchased at more or less fluctuating rates. In order to take care of the difference between the assumed fixed and the actual fluctuating cost, the difference should be determined at suitable periods, and this difference debited or credited, as the case may be, as a "market equaliser" affecting the profit and loss account. Should the fluctuations be large, it will be advisable to make use of a "special charging account" to properly analyse the influence of various brands of iron and scrap on the cost of the charge. Preference is to be given to determinations at short intervals—say quarterly—rather than longer ones, as changes can then be made in time to effect economies.

(*h*) Smelting materials: All fuel and flux charged into the cupola; fuel recovered from the bed is to be charged again into the cupola. Fuel for other purposes, such as drying ladles, cores, and molds, is to be charged under head (*e*).

As the market price of these materials also is apt to vary, and as it is desirable in the analysis to make use of a fixed price, the difference is taken care of by a "market equaliser," as previously explained.

(*k*) Recovered material: This account takes care of all difference between molten iron obtained from the cupola and the saleable castings. It is made up of:—

1. Equipment: Castings for foundry use, such as weights, flasks, chills, etc.

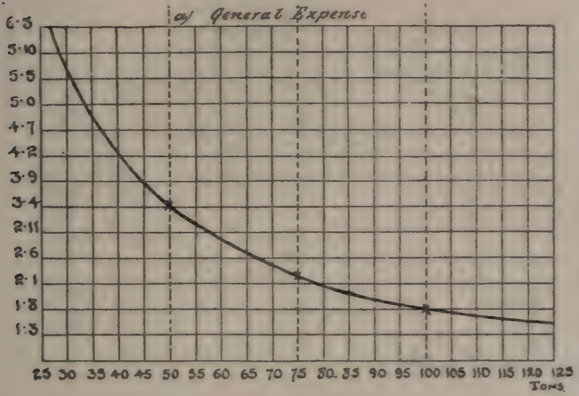
2. Upkeep: Castings made to repair or replace wastage of foundry equipment.

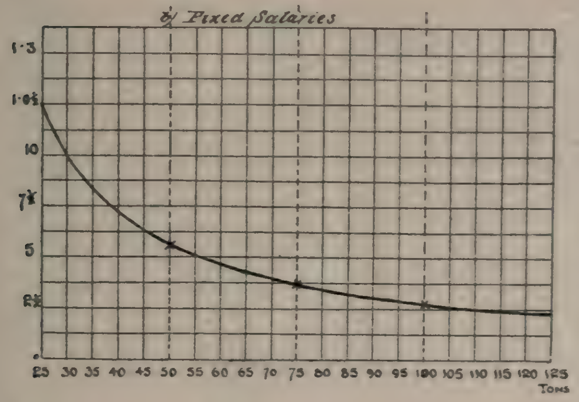
3. Gates : Gates, cast core irons and frames, sinking heads, and sprues.

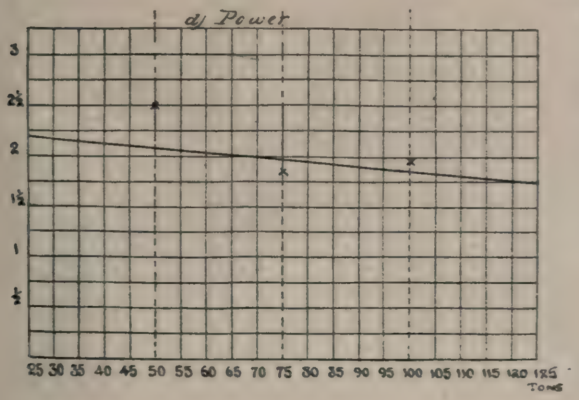
4. Wasters : All defective castings.

All of this material will either be present in the foundry or will be charged into the cupola as scrap. In the latter case it is certainly to be rated only at the same value as purchased scrap. In the first case it is conservative policy to rate the material no higher than scrap, as it is very questionable whether it would bring a higher return if sold.

As the material for producing the items under this head has been entered as a charge, its value should be credited to the total costs in order to give a true net total cost.







(*j*) Light : All charges directly connected with the shop lighting.

It is to be remembered that the divisions as here cited are merely suggestive of underlying ideas and principles ; in actual practice a larger number will be used, and many will be divided and subdivided. The labour charge, for instance, should be split up into direct and indirect labour, etc.

BASIS OF COST PER 200 LB.

In general it will be most convenient to reduce all elements to a basis of cost per 200 lb., or one-tenth ton, as a compromise that avoids the high figures for output when figured in pounds and yet allows ready reduction to the pound rate generally used in the sale of castings.

In comparing costs at different periods it will not do simply to divide the total cost incurred during a week by the total pounds produced during that week and take the result as a pound cost, to be compared with that of some other period. Every manager knows that the cost per pound rises when the product is small and decreases with an increasing output, and will take this into account when comparing costs. But such allowance is made as a matter of judgment only. Now, judgment is a very good thing, but certainty is still better if it can be made to take the place of judgment ; in this particular instance that can be done and quite readily. As an example, say that the fixed general expense charge for a week is £333 6s. 8d. ; with the output fifty tons, the charge per 200 lb. is then 3s. 4d. ; but for a doubled output of 100 tons the charge per 200 lb. would be halved to 1s. 8d. These values, plotted as a curve for various rates of output on the horizontal scale, give the diagram (*a*).

Similarly, that other element of fixed cost, fixed salaries, is plotted as diagram (*b*).

Fluctuating elements of cost are also so plotted, though from the nature of the case the curves cannot be determined by direct calculation, but must be approximately laid down in accordance with experience and judgment. In this way the diagrams for power (*d*), for miscellaneous materials (*e*), and for labour (*f*) are laid down as decreasing with an increase in production. Pig and other charging metal (*g*) and smelting material (*h*) are laid down as horizontal lines, as these items are not apt to be materially affected by the amount of the output.

All of these curves or lines I term ideal curves. Their total will give an ideal total cost of production, as shown in diagram (*i*), by the lower line, per 200 lb. of melted iron. If all the iron melted were turned into saleable castings, this lower, or 100 per cent., curve would represent also the cost of saleable castings. The other curves give the cost of saleable castings for the various ratios of such castings to the total iron melted. These curves are determined as follows : Take the total cost per 200 lb. of melted iron as 14s. 2d. the value of recovered iron as 10d, the saleable castings as 80 per cent. Then the 160 lb. of saleable castings would cost as much to produce as the 200 lb. of iron melted, less the value of the recovered iron, *i.e.* :—

	s.	d.
Cost of melted iron ..	14	2
Value of recovered iron	0	10
Cost of the 80 per cent. of saleable castings is the balance ..	13	4

and 200 lb. of saleable castings would cost $\frac{13/4}{4} =$ 16s 8d.

This can also be put as a figure to be added to the cost of the melted iron from the equation

$$s = \left(\frac{1}{p} - 1\right)(i - r), \text{ in which}$$

s is increase to be added to cost of melted iron to give cost of saleable castings;
p is percentage of saleable castings divided by 100;
i is value of melted iron;
r is value of recovered iron.

COMPARISION WITH IDEALS.

Considering in illustration values from diagram (i): The actual cost per 200 lb. of melted iron is 15s. 0½d. 12s. 10½d. and 12s. 6d. in the three periods shown. According to the ideal curve, the lower one marked 100 per cent., these costs should have been 14s. 2d., 12s. 9½d., and 12s. 1d. Running up the first week's cost, the manager finds that of the various items the cost for miscellaneous materials (e) was by far the higher as compared with the ideal laid down, and instructed the foreman to cut this. Next week the total is still found too high; following this through shows that miscellaneous material cost has been reduced actually below the ideal, but that the labour element (f) went up materially; investigation in the foundry showed that the foreman economised on sand mixtures and facings to such an extent as to apparently increase the cleaning labour; the apparent relation between these two elements of cost should be followed up to see whether it is actual. The best way is by a further subdivision of these two elements for some time. As before stated, the analysis is here carried only far enough to explain the idea; nor must the figures given be considered in any other sense.

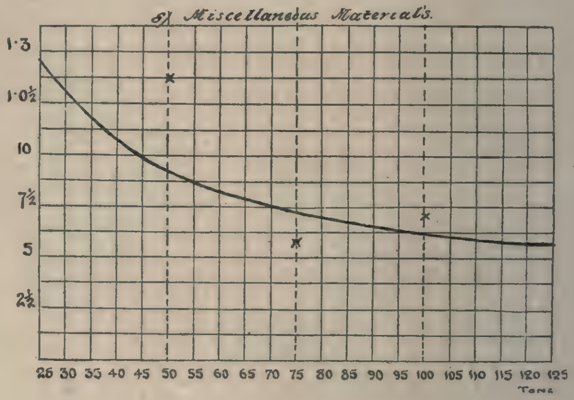
The following week the total is still found high as compared with the ideal, but more nearly satisfactory.

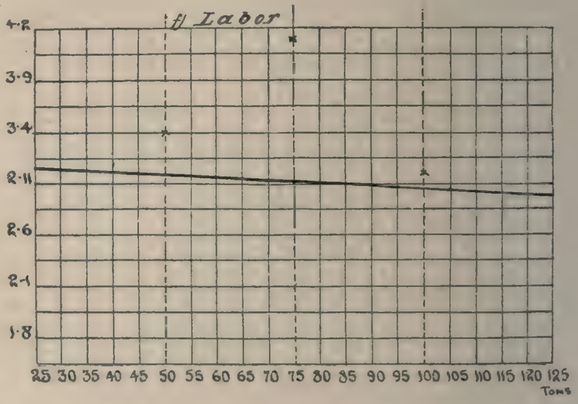
Looking further, the manager finds that the cost of the saleable castings is 18s. 4½d., 20s. 5d., and 13s. 8d. in the respective periods (entered as + points in the diagram), whereas they should have been but 16s. 8d., 18s.6d, and 12s. 10d., to correspond with the ratios of 80, 60, and 90 per cent. of saleable castings. The very low ratio (60 per cent.) of saleable castings in the second week is entirely too poor a showing to pass without comment. Tracing upward, it is found that the smelting cost (h) was very low, leading to the inference that economy of fuel had led to the very large amount of wasters; investigation in the foundry bore this out, as too dull iron, consequent on the use of insufficient coke, caused a lot of scrapping.

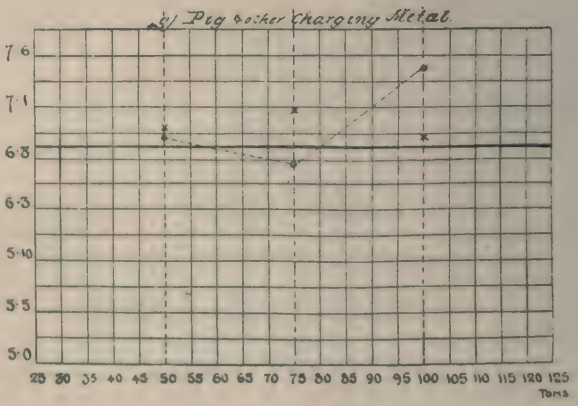
ADVANTAGES OF THE METHOD

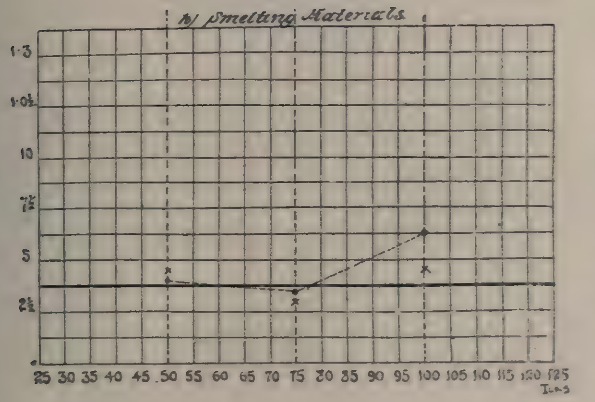
From what has been said it is apparent that this plan of plotting records and methods of analysis based on comparison with ideal conditions keep the busy manager up to date in his knowledge of what is actually going on, not only as regards totals, but also in detail, so that he is always in position to find a sore spot and apply a remedy based on certain knowledge, backing up his judgment. The method has the further advantage of showing whether the remedy applied really did result in the cure desired, or whether it merely brought about a transfer of the sore to some other place.

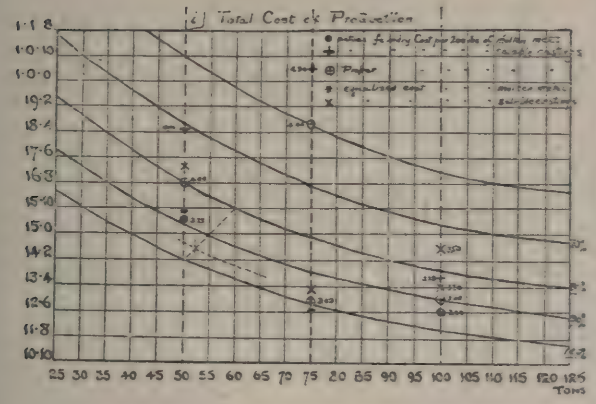
Knowledge of the fact of such close analysis being made will keep the foreman and others responsible tuned up to concert pitch. It has, in my experience, immediately on adoption resulted in a decrease in costs; showing the foremen actual figures will avoid much of the bad feeling easily raised with well-meaning men when their results are criticised. Being human, they are more or less inclined to ascribe criticism to prejudice. Under this method of absolute analysis responsibility will be placed where it belongs, and it will be possible to bestow praise judiciously in the proper quarter—the old adage to the contrary notwithstanding; "soft words do butter parsnips" to the decided advantage of the firm.

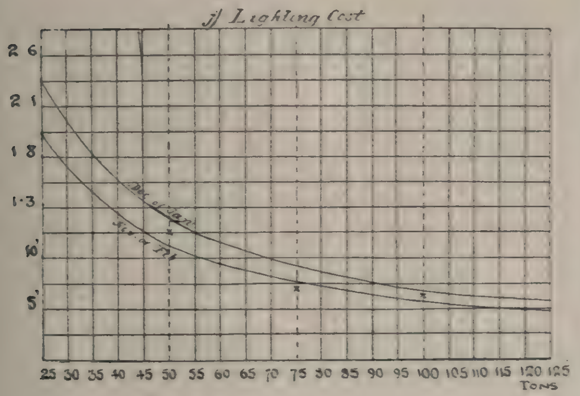












Note.—These diagrams should in practice be so bound together that the dotted lines run continuously over the entire series; that will permit a ready tracing of each period's output to the various elements. Plotting books as used by engineers will be found very useful for entering the diagrams.

MARKET EQUALISER.

In enumerating the elements of cost, mention was made of a market equaliser to take into account the fluctuating value of the materials bought; this is brought in as follows: the actual unit value of material used at any time is its average cost price; this may, according to circumstances, be either higher or lower than that due to the current market rate or than the ideal assumed. These actual costs of such material are plotted into the diagrams (*g*) and (*h*) with the sign **O**. The actual total costs as modified by the equaliser are also added on the total diagram (*i*) with the signs * and **X**. Consulting this, it will be seen that a recent purchase of pig and coke at high figures had the effect of raising the cost of the last week's output considerably—from 12s. 6d to 13s. 4d. per 200 lb. of molten metal and from 13s. 8d. to 14s. 7d. for saleable castings. The actual utility of separately considering this element is evident, as otherwise the more nearly satisfactory cost of production, so far as under the control of the foundry foreman, would have been obscured. The actual cost due to the market price of the materials being given will allow sales being based on that.

Lighting has not so far been taken into account as an element of cost; this because it is dependent upon the season and the weather, conditions that are not subject to control. This variable character would to a certain extent impair the value and reliability of the main analysis for purposes of cost comparison. I therefore prefer to plot it as an addendum diagram (*j*), and to consider its influence on costs separately. In determining sales prices this cost item must, of course, be added.

The totalling diagram (*i*) would be too greatly obscured were curves drawn in for more than each 10 per cent. of variation of saleable castings. It is, however, a very simple matter to interpolate points as desired: Say the 95 per cent. line is required at about sixty tons output. Mark the intersection of any vertical in that neighbourhood—say fifty with the 100 per cent. curve—then the intersection of the next heavy vertical at ten tons farther along with the 80 per cent. curve; then of the next heavy vertical, at seventy tons with the 60 per cent. curve; now pencil a curve through these intersections. As 95 is midway between 100 and 90, the intersection of the curve just pencilled in with the vertical midway between those cutting the 100 and 90 per cent. curves will be a point on the 95 per cent. curve sought. This latter may then be continued both ways approximately parallel to the curves between which it lies.

In conclusion, I may be permitted to point out that this method of cost analysis is not by any means restricted to the foundry, but is applicable advantageously to all lines of work in which the cost of production varies necessarily with some other factor; in most lines of manufacture that factor would be the output. Although rather lengthy to describe, the plan is not at all formidable in actual use. All the data required are assumed as available, being needed for any arrangement of recording costs that may be in use, so that there remains only the work of laying down ideal curves, and of plotting in the actual values; this latter operation is a very simple one, that can be quickly mastered by the average costing clerk.

Read before the Engineers' Club of Philadelphia.

NOTES AND NEWS.

Messrs. Royce, Ltd., of Manchester, have appointed as sole representative for the London district Mr. E. C. Amos, M.I.Mech.E., 20, Bucklersbury, E.C., from whom all particulars of the "Royce" dynamos, electric motors, cranes, switches, etc., can be obtained.

The British Westinghouse Electric and Manufacturing Company, Ltd., has secured a contract from the Manchester Corporation Tramways for the supply of the complete electrical equipments of a hundred tram-cars. The equipments, and in particular the motors and controllers, are of a type which has been developed with much care to meet the requirements of city tramway service, and of which a very large number has been sold.

Messrs. Lobnitz and Co., Ltd., of Renfrew, are to build for the Suez Canal Company a hopper dredger larger than any afloat. This dredger is of the bucket type, and very powerful. She is the seventy-eighth ordered by the Suez Canal Company, and, as hitherto, will be classed with Bureau Veritas. The firm at the present time is constructing another hopper dredger which has buckets each of fifty-four cubic feet capacity, this being also a record size.

It was decided at a recent meeting of directors of the North-Eastern Railway Company, at York, that an extensive installation of Westinghouse power signalling should be installed at the new Paragon Station, Hull, and the contract was let to Messrs. Mackenzie and Holland, of London and Worcester, the agents of the Westinghouse Brake Company. The apparatus will be of British manufacture, being made at the works of the Westinghouse Brake Company, Ltd., King's Cross, London.

The Wimbledon Urban District Council has accepted the tender of the Paterson Engineering Company, Ltd., for a water softener and filter, softened water storage tank, etc., in connection with the extension of its electricity works. The company lately received an order from the British Westinghouse Electric and Manufacturing Company, Ltd., for a Paterson combined feed-water softener and grease eliminator for the Northampton tramway power station, and from Messrs. Dick, Kerr and Co. for the Portsmouth tramway power station. Messrs. Harland and Wolff have ordered one of their condensation water purifiers for removing all oil from the feed water at their new central electric power station. The Paterson Engineering Company Ltd., has opened an office at Amberley House, Norfolk, Street, Strand, W.C.

Admiral Sir E. Seymour, in the course of a speech at the annual dinner of the Institution of Civil Engineers, said he thought it very satisfactory to see that the type of battleships extremely various twenty years ago, seemed to be settling down more into a single type. He was of opinion, as a sailor, that it was a mistake to go on increasing the size of our battleships any more. One reason was that, in these days of torpedoes and submarine mines and boats, it was putting too many eggs into one basket. He thought that the size of the battleship was a thing that should be somewhat limited. Referring to the war, he said that he knew some of the localities and one or two of the actors. As far as it had gone at present, it bore out the words of Bacon three hundred years ago, "He that is strongest at sea has had great liberty, for he may take as much or as little as he will of the war."

Dartford Destructor.

Dartford has now the benefit of an up-to-date refuse destructor plant by Messrs. Meldrum Bros., Ltd. The buildings which are of a very substantial character are placed next to the electric light works and sewage pumping station in Priory Road.

The destructor furnace is a two grate regenerate top feed type Meldrum "Simplex" refuse destructor, guaranteed to destroy 30 tons of ordinary house refuse per day of twenty-four hours. Its accessories include a Lancashire boiler, 30 ft. long by 8 ft. diameter; Sugden superheater, regenerator for heating the air to consume the refuse, Green's economiser, Hall's pump, Lassen and Hjort's water softener, Mather and Platt's water filter, etc., and are such as to ensure the whole of the available power being economically utilised, without sacrificing or impairing the completeness of destruction, which is the primary object of the plant.

Junior Engineering Society.

At a meeting of this Society, Mr. W. H. Pearce (member) read an instructive paper on "Valves and Valve Diagrams." A discussion by Messrs. G. H. Burrows (chairman), Bayley, Roberts and Deverell followed, the author being heartily thanked for his paper.

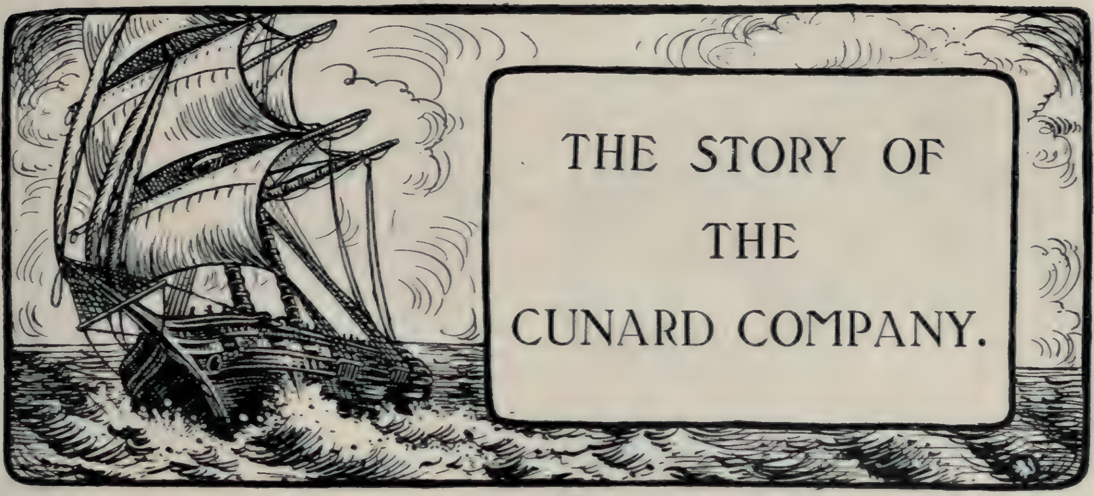
At the second intermediate meeting of the Junior Engineering Society the subject brought forward for discussion was the Great Western Company's engines "Albion" (simple), "La France" (compound). The engines were described by Mr. G. Burrows, whose remarks were followed by an interesting discussion, in the course of which Mr. J. W. Smith (Chief Draughtsman of the Midland Railway) stated he had had considerable experience both on the North-Eastern and Midland Railways with compound engines. The Midland people, after exhaustive experiments, had come to the conclusion that three-cylinder compound engines were the best. In his opinion, there was no doubt that compounding was the most economical method of working, and as regards repairs, one of the Midland compounds had now been running for two years without going into the shops.

Ventilation of the House of Commons.

In spite of the many attempts made to improve the ventilation of the Houses of Parliament, it is undoubtedly a fact that Members have experienced very depressing effects therein—effects which it is supposed have not on all occasions been due to the languor of debate. However this may be, it has now been decided to thoroughly overhaul the arrangements, and to install new ventilating plant.

Messrs. Matthews and Yates, Ltd., of Swinton, Manchester, also of London, Leeds, Glasgow, etc., have been entrusted with the order for this plant, and it is hoped by the commencement of another session to have it installed. Experiments already made give the assurance that such an improvement will be effected throughout, that members will have no further cause for complaint.

During the past two years or so, Messrs. Matthews and Yates have supplied some sixty or seventy fans for the ventilation of committee rooms, division lobbies, lavatories, etc., and it is doubtless due to the satisfactory working of these fans, and the results obtained therefrom, that they have now been entrusted with the larger work of ventilating the "House" itself.



THE STORY OF THE CUNARD COMPANY.

BY

BENJAMIN TAYLOR, F.R.G.S.

The history of the Cunard Company is, no doubt, to many people somewhat of an oft-told tale. While the Cunard Company have been undoubtedly fortunate, an examination of their history and methods will show that their luck has been deserved. No precaution which human foresight or the keenest business ability could devise has ever been forgotten or omitted.—Ed.

THE Cunard service was started just two years after the practicability of steam navigation on the Atlantic was demonstrated by the voyage of the *Sirius* from London to New York. She made the voyage in seventeen days, and was followed by the *Great Western*, which did it in fifteen days. Other vessels still further proved the practicability of doing what Dr. Dionysius Lardner had declared to be as impossible as a voyage to the moon—or something to that effect, but Dr. Lardner is not always correctly quoted. According to Mr. Hodder, the biographer of George Burns, one of the founders of the firm of G. and J. Burns, a matter so important did not escape the attention of Burns, to whom Sir Edward Parry, then Comptroller of Steam Machinery and Packet Service at the Admiralty, sent an intimation that the Government were about to invite tenders for a mail service between England and America. The idea of a steam service was by this time a common enough one, and was not (as is sometimes alleged) the invention of either Samuel Cunard or George Burns. The days of the " coffin brigs " were numbered, and the Admiralty advertisement for steamers was spread broadcast before Samuel Cunard appeared on the scene. George Burns thought carefully over the matter, but did not see his way to risk or lose the coasting trade, which he had built up, by embarking on so large an undertaking as an Atlantic service. His hands were full, or he thought they were. And then came the inspiring genius. " Away in Halifax, Nova Scotia, dwelt Samuel Cunard, a member of a well-to-do Quaker family, which emigrated from Wales to America early in the seventeenth century, and settled at Philadelphia. The family, being Royalists, left the United States for Halifax, and here in 1788 Samuel Cunard was born. After serving some time in a merchant's office, he so much distinguished himself that he was offered a partnership with one of the leading firms of shipowners in Boston Here he found scope for his great energy and ability, and entered into various enterprises, engaging with newly built vessels in the West Indian trade and in the South Sea whale fishery. In 1815, while still a young man, under thirty, he proposed to the Admiralty to undertake at his own risk the conveyance of mails between Boston, Newfoundland, and Bermuda, and carried out his scheme so satisfactorily as to earn the thanks of the British Government."

CUNARD'S IDEALS.

Thus Cunard was a shipowner, experienced in mail-carrying work, and favourably known to the British Government, before ever the Atlantic service was proposed. He paid close attention, however, to the experiments in steam navigation that were being made, and as early as 1830 began to dream dreams of ocean railways. It was his belief that steamers over a route of thousands of miles might start and arrive at their destinations with a punctuality like that of railway trains, if the ships were thoroughly well built and well manned, and their course laid down with accuracy. The steamship, he thought, was to be the ocean railway train *minus* the longitudinal pair of metal rails. The rails, Samuel Cunard used to observe, were needed only on the " ugly, uneven land," with its high hills and deep valleys, but the level sea did not need them.

HIS OPPORTUNITY.

It was one of the Admiralty circulars of 1838 (or 1839), which George Burns had considered and laid

LORD INVERCLYED.
Chairman of the Cunard Company.

aside, that first brought Cunard within sight of his opportunity. He knew what he wanted to do, but he had not enough capital to do it, and he could not persuade the merchants of Halifax to join him in the enterprise. Therefore, he went to London, and he obtained there a letter of introduction to Robert Napier, the famous engineer and shipbuilder in Glasgow, of whom we must present a note :—

"Robert Napier was a man worth knowing. He started life as an apprentice to his father, who was a blacksmith. At the age of twenty-four he received from his father the sum of £50—£45 of which he spent in the purchase of tools and the goodwill of a small blacksmith's shop in the Gallowgate, Glasgow, leaving £5 for working capital. By rapid steps his business developed; iron-founding and engineering were first added to it; then the building of marine engines; then the building of first-class steamers of all sizes for the mercantile marine, and for war purposes for various foreign countries as well as our own. His premises grew from the tiny shop in the Gallowgate to larger ones in Washington Street, engineering works in Lancefield, and the famous shipbuilding yard in Govan; and his staff, which at first consisted of only two apprentices, increased until upwards of three thousand persons were in his employ."

To this wonderful man, this father of marine engineering, went the prophet from Halifax. Napier knew Burns well, for he had engined the steamers of the Glasgow and Liverpool Line, with which G. and J. Burns had amalgamated. But he went first to James Donaldson, a wealthy cotton broker, and the moneyed man in a former opposition line of Liverpool steamers that Burns had won over. And this is what happened, as related by George Burns himself :—

INCEPTION OF THE SCHEME.

"It was arranged that when Cunard went to Mr. Napier, he was to take him to Donaldson, who on his part was to bring him to me. Donaldson came trotting down from his office, and told me Cunard and Napier were waiting for me, and had proposed that we should do something to get up a concern for carrying the North American mails. Donaldson said to me, 'I told Mr. Cunard that I never did anything without consulting a little friend of mine (meaning myself), and if he pleased I would bring him down to your office.' So down Donaldson came with Cunard, introduced him, and left him alone with me to talk it over. It was not long before we began to see some daylight through the scheme, and I entertained the proposal cordially. That day I asked Cunard to dine with me, and also David MacIver, who was at that time residing in Glasgow as agent for the City of Glasgow Steam Packet Company. I propounded the matter to MacIver, but he did not seem to see his way clear; on the contrary, he went dead against the proposal, and advised that after dinner I had better tell Cunard that the thing would not suit us. As talking after dinner generally ends in nothing, so it did on this occasion. However, Mr. Cunard asked us to come down and take breakfast with him and Mr. Robert Napier in Mr. Napier's house. We went accordingly, and after going into details I told Mr. Cunard we could hardly take up such a large concern as the proposal before us would amount to, without inviting a few friends to join us; and that as it would not be fair to keep him in suspense, we would set him free to make any arrangements he thought best with his own friends. He replied, 'How long will it take to ascertain what you can do?' I answered, 'Perhaps a month'; and he said, 'Very well, then, I'll wait.' That same day I set out and spoke first of all to Mr. William Connal, then at the head of a large firm engaged in the commission trade of produce and other things. Mr. Connal said to me, 'I know nothing whatever about steam navigation, but if *you* think well of it I'll join you.'"

The subscription was £5,000 each, and within a few days George Burns got together the whole capital of £270,000 required. Then, in due time, the tender was submitted to the Government for a fortnightly mail between Liverpool, Halifax and Boston. The tender was accepted over that of the owners of the *Great Western*, and the contract was signed by Samuel Cunard, George Burns and David MacIver.

But this is not the whole story of the origin. The following is taken from a letter written in 1895 by John Napier, son of Robert Napier, narrating the story as told to him by his own father :—

"The Hon. Samuel Cunard, being in London in the latter end of 1838, consulted his friend Mr. James Melvill, secretary of the old East India Company, as to vessels he required to carry out a contract he had for conveying the mails between England and America. Melvill recommended him to communicate with my father, and this he (Cunard) did on February 25th, 1839, through his correspondents in Glasgow, Messrs. William Kidston and Sons, whom he asked to get an estimate from my father for 'one or two steamboats of 300 h.p. and about 800 tons. In reply to this inquiry my father, on February 28th, 1839, wrote Kidstons, making offer to supply Mr. Cunard with the vessels he asked for. A few days after that Cunard came to Glasgow and saw my father, and explained to him fully his requirements, with the result that he accepted an offer from my father to build three vessels of 800 tons and 300 h.p. for the sum of £30,000 each. On, however, thinking more over the matter and the nature of the trade the vessels were to be employed in, my father became convinced that they were too small, and urged Cunard to make them larger, which in the end he agreed to do, and on March 18th, 1839 (the offer and acceptance of the small vessels being cancelled), a detailed and stamped contract in duplicate was signed at Glasgow by 'S. Cunard' and 'R. Napier.' The vessels were now to be each 200 ft. long, 32 ft. broad, and 21½ ft. depth of hold, with engines having 70 in. cylinders and 6½-ft. stroke, all finished complete in cabins, etc. (similar to vessels my father had lately built for the City of Glasgow Company), and the price for each of the three vessels was to be £32,000.

"On March 21st, writing from London to my father, Cunard, amongst other things, mentions that he had been to the Admiralty and Treasury, who, he says, 'are highly pleased with the size of the boats.' My father, however, was not yet pleased with the size. He still thought them rather small for such a long voyage, and felt that larger vessels would be more economical, and he said so to Cunard, who, however, stuck to the size as had been fixed. He (Cunard), however, when again seeing his friend Melvill in London, and telling him about the contract he had made, told him also that my father still thought the vessels rather small, and that were they larger they would in the end be more economical, and he (Cunard) at the same time told Melvill that, were it not for the expense, he would go in for rather more size, but that unless he could get up a company, which up till now he had failed in doing, he could not build larger vessels.

"On hearing that, and thinking over it, Melvill advised Cunard to go at once back to Glasgow and lay his difficulties unreservedly before my father, as very likely he and his friends could help him, even in the formation of a small company, and so allow of more suitable sized vessels being built. Cunard took Melvill's advice, and returned to Glasgow and stated his difficulties to my father, who, after considering the matter, thought he saw his way to help. Now, shortly before the time of which I am now speaking, there were two powerful companies running in tooth-and-nail opposition to each other between Glasgow and Liverpool. The one was managed by Messrs. Martin and Burns, and the other by Messrs. Thomson and McConnell. My father was a shareholder of the latter company, and engined their vessels. At the beginning of 1839, however, these two opposing companies (having come to an understanding with each other) were working together harmoniously, and my father, thinking it might bind them more closely were he to get their principal shareholders to take an interest in Cunard's undertaking, saw first his friend James Donaldson, and one or two other shareholders of the Glasgow and Liverpool Company he (my father) was connected with, and then he called on George Burns (of Martin and Burns, the agents of the other Glasgow and Liverpool company), with Donaldson and Cunard, and introduced the latter to Burns, who, after hearing Cunard's views, and seeing the possibilities of his mail scheme, got his friends to join with Donaldson and my father's friends (in all about 30), and to subscribe the needed amount of capital towards the proposed company—the company now known as the 'Cunard Company.'"

The reason why Samuel Cunard went to Melvill was that Cunard was agent in Halifax for the East India Company, of which Melvill was secretary, and the reason why Melvill recommended Robert Napier to supply the steamers was that in 1836 Napier had engined the steamer *Berenice* for the East India Company. This was the first ocean-going steamer he engined, and she was so successful that a great friendship sprang up between Napier and Melvill. The *Berenice* made the voyage to India, *via* the Cape of Good Hope, at the rate of eight knots an hour, with a consumption of eight tons of coal per day.

GEORGE BURNS.

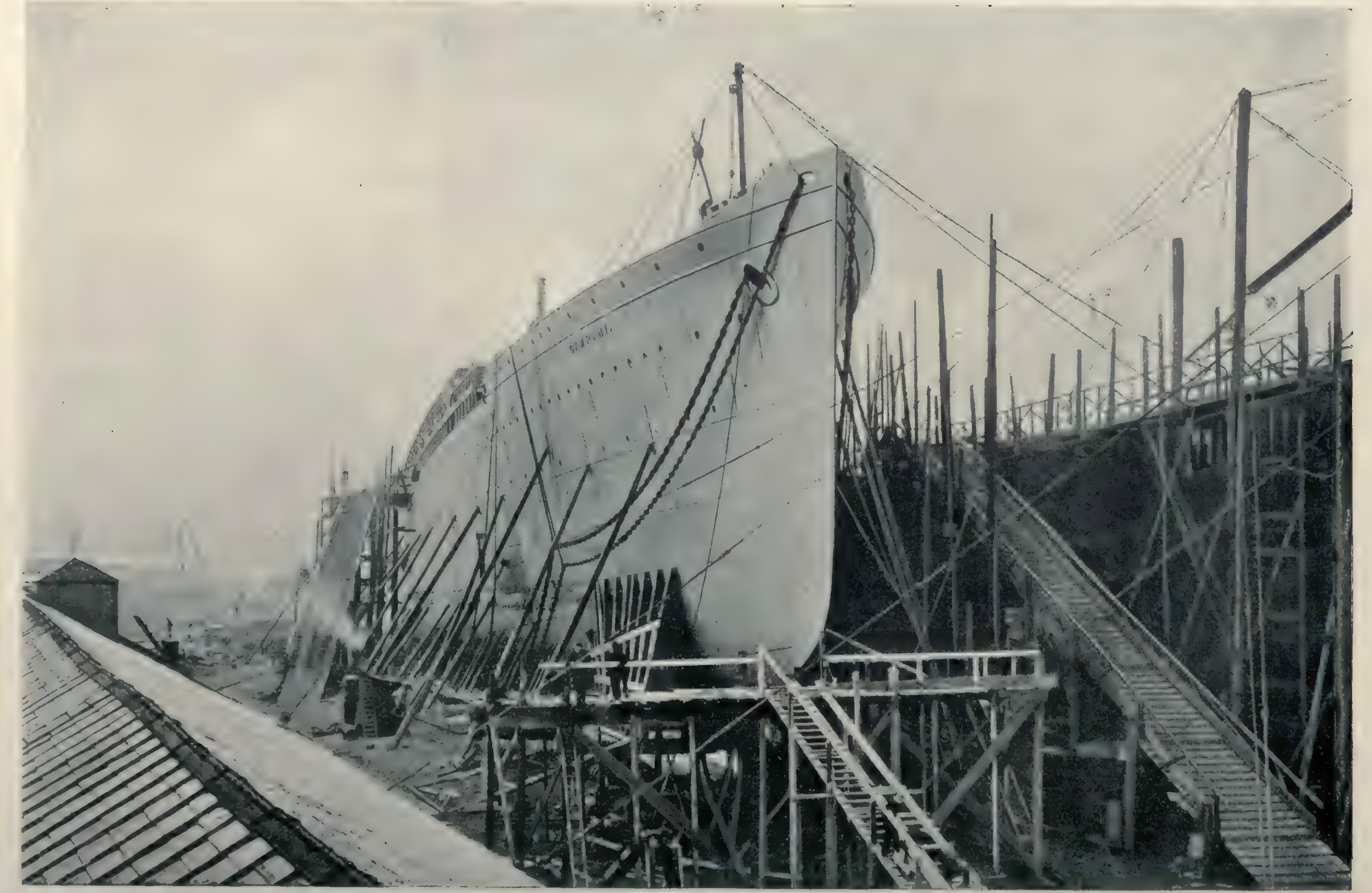
George (afterwards Sir George) Burns was born in 1795, and the initiation of the new fast service will probably mark his 110th year. He was the son of the minister of the Barony Parish, Glasgow, and after preparatory work in the office of the Cotton Spinning Company, originated by the famous David Dale (and afterwards carried on by Robert Owen, the Socialist), began business in 1818 in partnership with his brother James. As "sons of the manse" they were favourably regarded, and being honourable, shrewd, persevering, far-sighted and enterprising, though cautious, they soon made a name and position for themselves. They started as "general merchants," but chiefly in grain and produce. George did the travelling, and James attended to the counting-house. In 1824 they secured the agency for Matthie and Theakstone's line of Liverpool and Glasgow sailing smacks. This was their beginning with shipping, and as it developed George devoted himself entirely to this branch of the business, leaving the produce department to the management of James. And the produce business, under the firm-name of J. and G. Burns, was carried on until the death of James, while the shipping business was carried on in separate premises, under the firm-name of G. and J. Burns. Soon after securing the smack agency, the Burnses purchased a share in the smacks, and shortly after that they received the agency for a line of steamers which some people in Belfast had decided to establish between that city and Glasgow. George Burns' connection with steam began in 1824, and by the time Cunard appeared, in 1838, G. and J. Burns had lines of steamers of their own running from Glasgow to Liverpool, to Belfast, to Ayr, and to the West Highlands—the last-named being the line now carried on by David MacBrayne and Sons.

THE FIRST CUNARDERS.

The company formed with Cunard was "The British and North American Royal Mail Steam Packet Company," with a capital of £270,000, the bulk of which was provided by George Burns and David MacIver. The dimensions of the first Cunarders were :—

Vessels.	*Tons.*	*Length.*
Britannia	1,156	207 ft.
Columbia	1,138	207 ft.
Acadia	1,136	206 ft.
Caledonia	1,138	206 ft.

They were all wooden paddle boats, and their speed at sea was about 8½ knots. The tender of the Cunard Company for a fortnightly mail service from Liverpool to the United States was at an annual subsidy of £55,000. The sailings were afterwards made weekly, and the subsidy increased to £81,000 a year. The first vessel, the *Britannia*, sailed on her maiden voyage on July 4th, 1840, so that the line is now sixty-three years old. The next ships built were the *Cambria* and *Hibernia*, of 1,422 tons and 9¼ knots speed, and by 1848 the company had built four more vessels—named *America*, *Niagara*, *Canada*, and *Europa*—all paddle steamers of 1,825 tons and 10¼ knots.



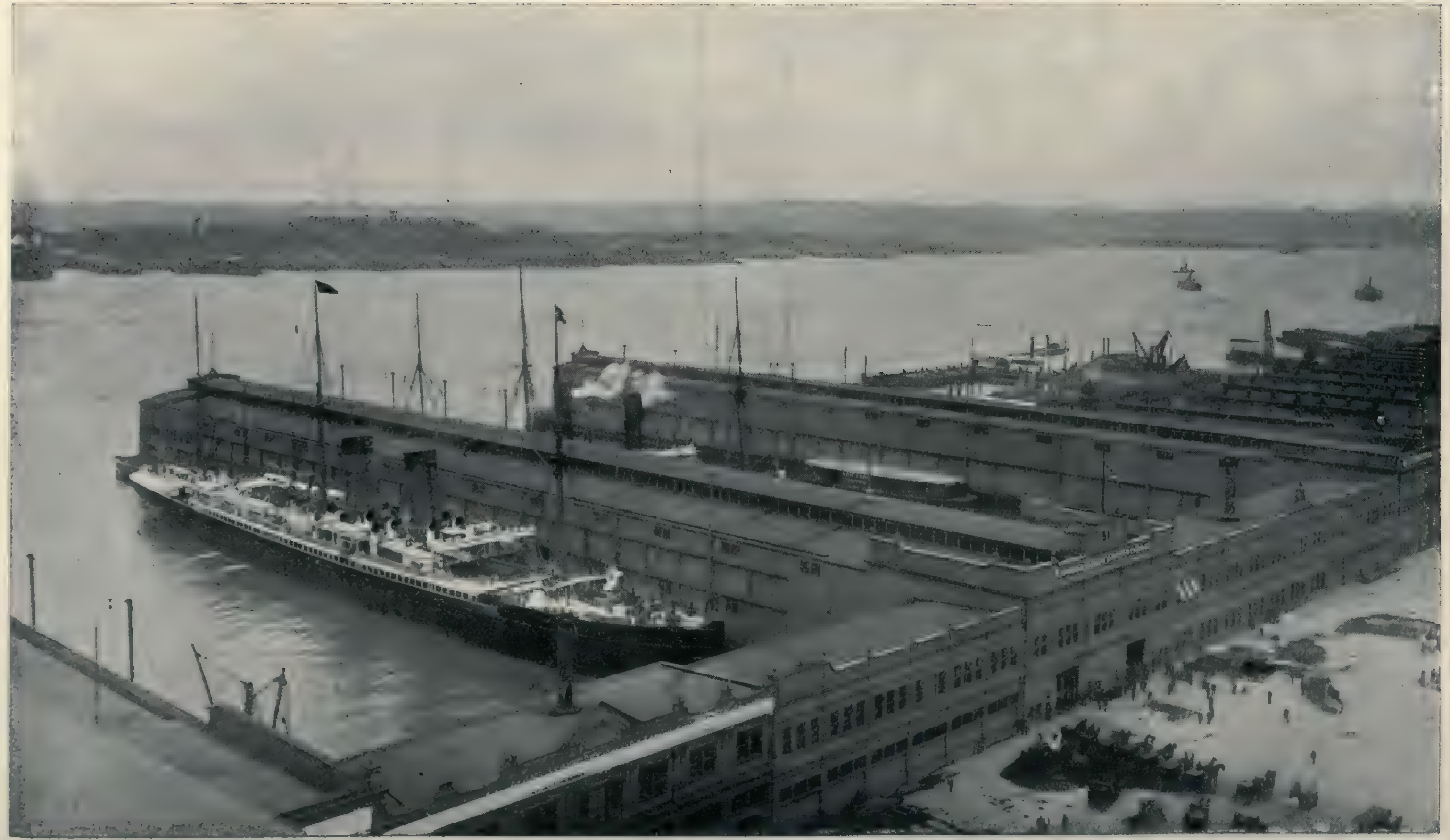
THE STEAMSHIP "CAMPANIA" ON THE WAYS.

THE CUNARD STEAMSHIP "LUCANIA."

The original subscription list was as follows —

	Shares.	
James Donaldson, cotton broker ..	160	£16,000
James Browne, insurance broker ..	116	11,600
James Wright, cotton broker ..	116	11,600
Thomas Buchanan, merchant ..	116	11,600
James Campbell (of J. and W. Campbell), warehouseman ..	60	6,000
Robert Hinshaw, drysalter ..	119	11,900
Alex. Downie, of Downie and Maclure	55	5,500
Wm. Brown, of Kilmardinny ..	116	£11,600
Robert Napier, shipbuilder ..	60	6,000
Robert Rodger, merchant ..	116	11,600
Wm. Campbell (of J. and W. Campbell), warehouseman ..	55	5,500
Wm. Leckie Ewing, of Arngomery	116	11,600
Arch. McConnell, of Thomson and McConnell	20	2,000
Wm. Connal, West India merchant	116	11,600
George Burns, of G. and J. Burns ..	55	5,500

DRAWING-ROOM ON BOARD THE "LUCANIA."



THE CUNARD COMPANY'S PIERS AT NEW YORK.

	Shares.	
James Burns, of G. and J. Burns ..	55	£5,500
David MacIver, of Burns and MacIver	40	4,000
Charles MacIver, of Burns and MacIver	40	4,000
Alex. Fletcher, calico printer ..	116	11,600
Alex. McAslan, of Austin and McAslan	105	10,500
Alex. McAslan, of Austin and McAslan	3	300
Wm. Stirling, of Stirling, Gordon and Co.	116	11,600
Elias Gibb, wine merchant ..	64	6,400
Jas. Merry, of Merry and Cunninghame	37	3,700
David Chapman, of Thomson and McConnell	15	1,500
Alex. Glasgow, of Auchenraith ..	64	6,400
Alex. Bannerman, Manchester ..	21	2,100
John Bannerman, Manchester ..	21	2,100
Henry Bannerman, Manchester ..	21	2,100
James Martin, of G. and J. Burns ..	16	1,600
David Scott	16	1,600
James McCall, of Daldowie ..	13	1,300
Alex. Kerr, of Robertland ..	7	700
Samuel Cunard, Halifax, N.S. ..	550	55,000

(Stock of 2,700 shares and £270,000, 1839.)

THE ORIGINAL SUBSCRIBERS.

With the exception of Samuel Cunard, a Nova Scotian, all the subscribers were Glasgow men. The MacIvers (the Liverpool partners of the Burnses) were resident in Liverpool, and the Bannermans in Manchester, the latter being brought into the concern through their brother-in-law, James Campbell, of J. and W. Campbell and Co., Glasgow. The Campbell-Bannerman family interest was the largest (£17,800). Mr Leckie Ewing was a family connection of the Campbells. George Burns, the real founder of the company, was the last survivor of the original partners' and died in 1890, aged ninety-four. Samuel Cunard, the nominal founder, brought in £55,000, but George Burns, the life and soul of the promotion, found all the rest of the capital. At first his partners—the MacIvers, Martin, and his own brother, who was his senior—held back, but his perseverance succeeded in carrying them all along with him. Sons of some of the original subscribers are alive, such as, notably, Mr. James A. Campbell, M.P. for Glasgow University, and Sir Henry Campbell-Bannerman, M.P., both sons of Sir James Campbell; while sons of Mr. Leckie Ewing and Mr. Browne survive in Mr. Robert Leckie Ewing, of Arngomery, and Mr. R. B. Browne, of Bendarroch, Dumbartonshire, formerly of Browne, Easton and Co., of the Glasgow Underwriters' Rooms and Lloyds.

INTRODUCTION OF IRON SHIPS.

For twenty years the vessels of the Cunard line were built of wood, the transition to iron being delayed by the refusal of the Government to allow the mails to be carried in iron ships. But in 1860 this restriction was withdrawn, and the *Persia*, an iron paddle steamer of 3,766 tons was built. Her length was 350 ft. and her h.p. 3,600. The *Scotia*, which for some time held the record of eight days twenty-two hours from New York to Liverpool, was the last of the big paddle boats constructed for the Cunard. She was built in 1862, and was of 3,871 tons, 4,200 h.p., and 367 ft. length. She was later converted into a twin-screw vessel, and did service as a cable steamer. The *China*, launched in 1862, was the first Cunard screw steamer. In 1867 came the *Russia*, of 2,960 tons and 3,000 h.p., which averaged more than 14 knots, and reduced the record from New York to Queenstown to just over eight days. Subsequent crack Cunarders were the *Batavia*, 2,553 tons; *Calabria*, *Algeria*, and *Abyssinia*, each of 3,300 tons; *Scynthia* and *Bothnia*, 4,535 tons; and *Gallia*, 4,808 tons. Steel next began to replace iron as the material for shipbuilding, and in 1881 the *Servia*, of 8,500 tons and 530 ft. long, was launched on the Clyde. In January, 1882, she broke the record with a passage from New York to Liverpool in seven days eight hours fifteen minutes, but a few months later the Guion liner, *Alaska*, ran from New York to Queenstown in six days twenty-two hours. In 1888 the Cunarder *Etruria* did the westward passage in six days one hour forty-seven minutes.

MODERN CUNARDERS.

The history of the Cunard Company had been closely bound up with the struggle for the "blue ribbon" of the Atlantic. The *Servia* was 540 ft. in length, and was the longest ship that had then (1882) been built, though she was soon eclipsed in this respect by the Anchor liner *City of Rome*. The *Servia's* sea speed was 17½ knots. In 1884, however, the *Umbria* and *Etruria* were launched. These were sister ships, each of 8,127 tons, and 501 ft. in length, with an indicated h.p. of 14,500. The fastest time of these vessels was done by the *Umbria* on her eighty-second trip, when she ran from Queenstown to New York in five days twenty-two hours, an average speed of 19·57 knots. In 1891 the most modern of the big Cunarders were ordered. These were twin-screw boats, the *Campania* and *Lucania*, the largest vessels (except the *Great Eastern*) ever built up to that period. They were launched by the Fairfield Shipbuilding Company in September, 1892, and February, 1893. The dimensions of these vessels are:—

Gross tonnage	12,950
Net tonnage	4,975
Length over all	620 ft.
Length between perpendiculars	601 ft.
Beam	65 ft. 3 in.
Depth from upper deck	43 ft.
Indicated h.p.	30,000

Of the two the *Lucania* is slightly the faster. Their usual sea speed is from 21½ to 22 knots per hour, and their record voyages are:—

	Outward.			Homeward.		
	Days.	hrs.	mins.	Days.	hrs.	mins.
Lucania ..	5	7	23	5	8	38
Campania	5	9	6	5	9	18

The Cunard Line boast that not a single passenger ever lost his life through a mishap to one of their vessels. The worst loss the Cunard Company ever sustained was that of the *Oregon*, a fine new steamer which, on March 14th, 1886, was sunk by collision with an unknown schooner near Long Island, but all those on board were safely transferred to the boats, and not a life was lost. The *Pavonia* once drifted about for days in a gale with her boilers loose, but was towed to harbour, and the *Etruria* in 1902 lost her propeller, and yet was taken into port without further damage. The Cunard Company have of late years adopted the policy of building large first-class twin-screw intermediate steamers of great cargo capacity, fair sea speed, and with accommodation for a limited number of passengers, such as the *Saxonia* and *Ivernia*.

(*To be continued.*)

Specially taken for "PAGE'S MAGAZINE."] [*Elliott and Fry.*

PROFESSOR PERRY AT WORK IN HIS STUDY.

OUR MONTHLY BIOGRAPHY.

PROFESSOR JOHN PERRY, M.E., D.Sc., LL.D., F.R.S.,

Whit. Schol., Assoc.M.Inst.C.E., Professor of Mechanics and Mathematics at the Royal College of Science.

PROFESSOR PERRY was born in Garvagh, County Derry, in 1850, and spent the early years of his life in that secluded market town, where it was the fashion to think and act for oneself. There there can be no question but that this circumstance, combined with healthy outdoor life, had a marked influence upon his mental training.

Professor Perry comes of a literary stock. All the family, it seems, wrote verses except himself, and it is not surprising to hear that in such an environment he was fond of Scott and Cooper at nine, and enjoyed Shakespeare at twelve years of age. At the present time he is an omniverous reader of general literature, with a special penchant for historical works, and in this connection it is interesting to note that, although a French and German scholar, he prefers to use even the worst published English translation of a foreign book rather than read the original.

At the Model School at Belfast he carried off numerous prizes, and secured a silver medal in natural science, and on matriculating at Queen's College, Belfast, he obtained a science scholarship and the Peel prize in geometry. A series of additional prizes and exhibitions, including Whitworth Exhibitions in 1868 and 1869 and a Whitworth scholarship in 1870, culminated in the latter year when he graduated as Bachelor of Engineering in the Queen's University of Ireland with first class honours, a gold medal and the Peel prize.

His earliest practical training was gained during an apprenticeship to Messrs. Coates, of the Lagan and Prince's Dock Foundries, Belfast. He is of the opinion that for a student to know great men is a very important factor in his education; his professors were nearly all well-known men—Purser, Thomas Andrews, James Thomson (brother of Lord Kelvin), Wyville Thomson, and others.

Professor Perry was lecturer in physics at Clifton College 1870-74, and there started the first School Physical Laboratory and Workshop, which are still thriving institutions. In 1874 he acted as secretary to the A section of the British Association, and in the same year became Thomson scholar and honorary assistant to Sir William Thomson (now Lord Kelvin) in Glasgow.

In 1875 Dr. Perry went to Japan as joint professor (with the principal) of engineering in the Imperial College of Engineering, and returned to England in 1879. Professor Perry says that in patriotism, in courage, in character, in all that goes to make what we call *soul*, the Japanese people are ahead of all other nations. In conjunction with Professor Ayrton, he did so much electrical work that Professor Clerk Maxwell jocularly remarked that the electrical centre of gravity had removed to Japan.

His activities since his return from Japan have been manifold. His first task was to organise the works of Messrs. Clark and Muirhead, introducing large tools, machinery for the covering of wire with gutta percha, etc., and for the testing of dynamos.

Professors Ayrton and Perry were appointed joint engineers to the Faure Accumulator Company a few months after it began work, and remained in that capacity until the English patents were disposed of. They lighted, among other places (in 1883), the Grand Hotel, Charing Cross; arranged the driving of tramcars and tricycles and experimented on accumulators at the manufactories in Liverpool and Paris. The only motors which gained prizes at Paris in 1889 were of their invention. They invented multipolar dynamos in 1882, and their other joint inventions are numerous. On the death of Professor Fleeming Jenkin, Dr. Perry became engineer of the Telpherage Company, and from July to October, 1885, superintended the erection and setting to work of the telpher line at Glynde, in Sussex.

In 1882 he became Professor of Mechanical Engineering and Applied Mathematics at the Finsbury Technical College, and in 1896 he became Professor of Mechanics and Mathematics in the Royal College of Science, London.

Of the lectures to students, and the papers which he has contributed to the technical societies, we can only mention a selection. He wrote many of the mathematical and physical articles in Blackie's "Cyclopædia," and published an Elementary Treatise on Steam, issued by Macmillan in 1873; his book on Practical Mechanics is well known. Other works include "The Calculus for Engineers," and "Steam, Gas, and Oil Engines." His first scientific paper was read before the Royal Society of London early in 1875, on "The Electric Conductivity of Glass as Dependent on Temperature." In partnership with Sir William Thomson, he read a paper on "Capillary Surfaces of Revolution" in 1875 before the Royal Society of Edinburgh. The Society of Arts in 1881 awarded him their silver medal for a lecture on "The Future Development of Electrical Appliances." In 1882 he delivered a course of Cantor Lectures on hydraulic machinery. At the Leeds meeting of the British Association he delivered the Operatives' Lecture on "Spinning Tops" (this is now published as a small book by the S.P.C.K., and is also being published in German).

Professor Perry arranged the system of technological examination in mechanical engineering of the City and Guilds' Institute. As a chairman of the examiners in the seven engineering subjects of the Science and Art Department, he has now more influence over methods of teaching in science classes. The publication of his lectures on "Practical Mathematics to Artizans" (Spottiswoode, 1899, and just translated into German) first acquainted the public with the value of some of his evening courses at Finsbury twenty years ago; the method is now being adopted in Germany and America. A result of the B.A. discussion in 1901 (published by Macmillan) is that a reform has already begun in the teaching of mathematics, and great changes have already taken place in the Oxford and Cambridge local examinations, as well as those of the Civil Service Commissioners. Young boys are now doing experimental mathematics, using squared paper, and the language of the infinitesimal calculus; and the subject of practical mathematics, is being taught to hundreds of thousands of students. His addresses as President of the Institution of Electrical Engineers (1900–1), and as President of Section G of the British Association (1902), his inaugural address at the Royal College of Science (1902), his address at Oxford (published in "Nature," December 31st, 1903), and many other addresses, memoirs and letters, have given rise to discussions on education. Professor Perry has unquestionably considerable originality of ideas in educational matters, and has always been fortunate in choosing the psychological moment for acting upon them.

A NEW 4-TON STEAM-HAMMER.

THIS steam hammer, nominally 4 tons, is of the "Girder" type, that is, the cylinder is carried on a girder supported at each end by a column. The girder is built up of steel plates and angle bars, and the columns are of cast iron.

In forging large masses of iron or steel, it is, of course, a great advantage to the forgemen to have plenty of room all round the hot forging wherein to carry on their work, and in designing the hammer, Messrs. Davis and Primrose, of Leith, have afforded convenience for this in a marked degree, the space between the columns being 17 ft., with a clear height of 11 ft. to lowest flange of girder.

The cylinder is 26½ in. diameter of bore, or, say, 552 square inches of area, and the permissible length of stroke, 66 in. There being 80 lb. per square inch of steam pressure on the top of this piston, a force of 20 tons is exerted in a downward direction, and the weight of the piston-rod itself, being 4 tons, the falling weight may be stated as 24 tons.

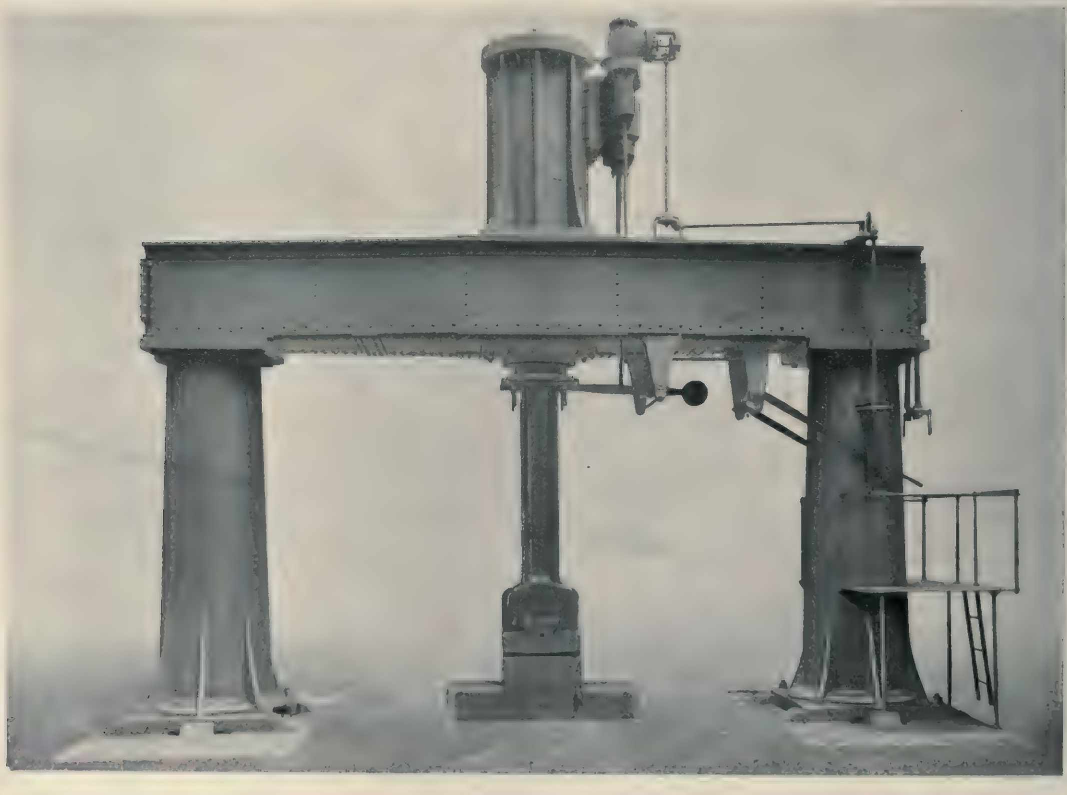
The driver stands on the small elevated platform seen on the right, from which position he has a clear view of the forgeman, who gives him his orders, also of the forging that he may be going to strike with the hammer. There are double handles, so that the driver can work the hammer from either side of the column.

The columns are each bolted to a base-plate, the two base-plates are kept in position by strong ties and struts, also bedded into ground, and concrete.

The anvil block is a casting of 32 tons weight, having a base 7 feet square resting on timbers and concrete. The anvil is held in the block by dovetail and key.

For guiding the piston-rod there are two flats planed on it, and the lower part of the cylinder has a long stuffing box of a special design of the makers, which, with the massive steel Gland, forms a capital guide.

The complete equipment embraces two forge cranes, each capable of carrying 20 tons, two heating furnaces, and the necessary boilers for raising steam.



NEW 4-TON STEAM HAMMER BY MESSRS. DAVIS AND PRIMROSE, LEITH.

VANCOUVER HARBOUR.

Mining in British Columbia and the Klondyke.

IN Mr. A. G. Bradley's new book on Canada in the Twentieth Century,* there is an interesting reference to the mining possibilities of British Columbia, a number of pages being devoted to Vancouver, which is not only an outfitting centre for the mining regions in the interior, but also for the great Klondyke and Yukon district of the far north.

"A number of people in Vancouver are interested in mines, and may be described just now as 'staying with their investments,' occupying themselves in the meantime with more active concerns. The auriferous regions of British Columbia are immense, so are the coal, iron, copper, and silver-lead depôts. In spite of the busy districts and mining centres such as Nelson, Rossland and Greenwood, they are as yet but faintly known and scarcely trenched upon, but everyone is aware that gold mining has been, and is, a brisk industry in the province, and that the latter has a market of its own, and has had its boom. The memory of this rankles in the minds of most British Columbians, and still more in that of others who are not residents of the Pacific province. There is no question whatever of the potentialities of the country, but confidence in it abroad was temporarily shaken, if not shattered, by the unwisdom of its immediate friends and exploiters. Men lost their heads, and for the most part their money, in reckless speculations, and the market acquired such a reputation for wild-cat schemes that the outside investor was ultimately choked off, and buttoned up his pocket relentlessly against all further propositions from British Columbia. Thus was a good thing spoilt by the short-sighted folly of those who had its making in their hands—spoilt for the time that is to say. The paying mines do not cease to pay on account of paper speculations among the mountains surrounding them, and no doubt confidence will one day be restored to a field that itself has given no cause whatever to forfeit it. One hears a great deal of the Yukon in Vancouver—that far away mysterious mining region generically known in England as Klondyke. One meets many people from there wintering in Vancouver, who are glad enough to exchange the temperature of 45 deg. and even 60 deg. below zero for a winter like Bournemouth or Ilfracombe. Steamers run from Vancouver for a thousand miles through countless islands to Skagway in Alaska, and thence passengers for the Yukon proceed by rail over the famous 'White Pass' to Dawson City, six hundred miles away and in British territory. The terrors of the old route to Klondyke, the dangers by land and water, by frost, hunger and mysterious diseases, were in the later nineties of world-wide notoriety, and were in no wit exaggerated. I have been much in company with many people on the coast who went through them all, and have heard tales enough of their adventures to fill a book. But now they go backwards and forwards by rail and steamer in luxury, though at great expense, while Dawson has every convenience of an ordinary North American city—though at twice or three times the cost."

Although designed chiefly for the general reader and largely devoted to agriculture, Mr. Bradley's work will be useful to any young engineers who have fixed upon Canada as their objective, owing to the fact that it is based upon the very latest conditions of Canadian life. There are numerous plates, which include the accompanying view of Vancouver Harbour.

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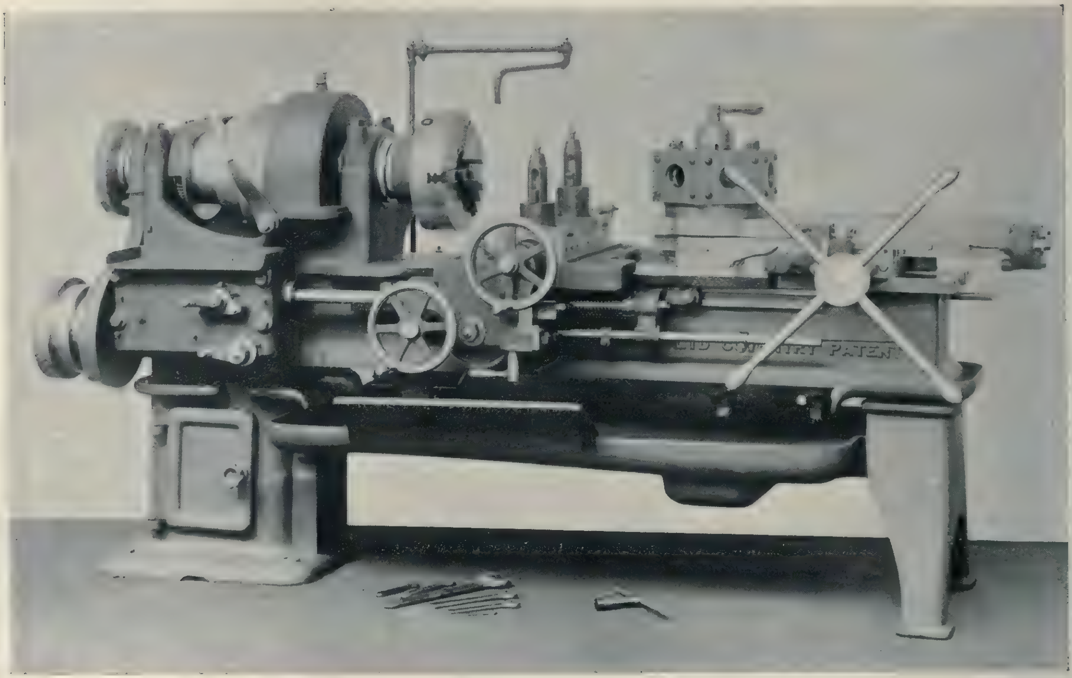
* "Canada in the Twentieth Century," by A. G. Bradley. 16s. net. Published by Archibald Constable and Co., Ltd.



NEW LATHE BY MESSRS. ALFRED HERBERT, LTD.

A NEW ACCESSORY FOR MOTOR MANUFACTURERS.

THIS is a machine which has been recently developed by Messrs. Alfred Herbert, Ltd., mainly for dealing with medium size chuck work, and has been very largely supplied to manufacturers of motor cars for making parts from bars too large to go through the spindles of the ordinary turret lathes.

The machine in question has 9-in. centres and has 3⅝-in. hole through the spindle, thus enabling bars of considerable size and weight to be handled.

The hexagon capstan is a feature of great utility when the lathe is used on large bars, as it enables special tools of considerable size to be firmly attached to its faces. In the case of an ordinary capstan lathe there is difficulty in using a tool beyond a certain size and weight on account of the limit set by the strength of the shank of the tool.

The lathe is fitted with patent chasing saddle in which chasing is done by means of a leader enabling any required pitches to be cut without any danger of cross threading, and without rendering it necessary for the lathe to be reversed.

The movement for engaging the nut with the leader also engages the tool with the work, the reverse movement withdrawing the tool and disengaging the nut. The leader, being removable, can be made with a pitch which bears an even ratio to the pitch to be cut, thus preventing danger and doing away with all difficulty in engaging the nut in the proper place.

Each leader will cut four pitches, these pitches being determined by the lower of the two handles in the feed-box, and the screws produced may be either right or left hand, the hand being determined by the upper of the two levers.

The capstan slide itself is adjustable along the bed and has six automatic feeds. It has also six independent automatic stops, one for each tool in the turret. These stops are carried by a hexagon bar at the front of the capstan slide, and this bar is geared so as to rotate with the capstan, so as to bring the correct stop into operation at the proper time.

In many cases, especially when used for making motor car gears from solid bars, the tools are provided with automatic oil feed through them. In this way they are lubricated right on their cutting points and the pressure of the oil supply tends to wash out the hole and keep it clear from chips.

DREDGING OPERATIONS AT THE LOWER BARRAGE ON THE NILE.

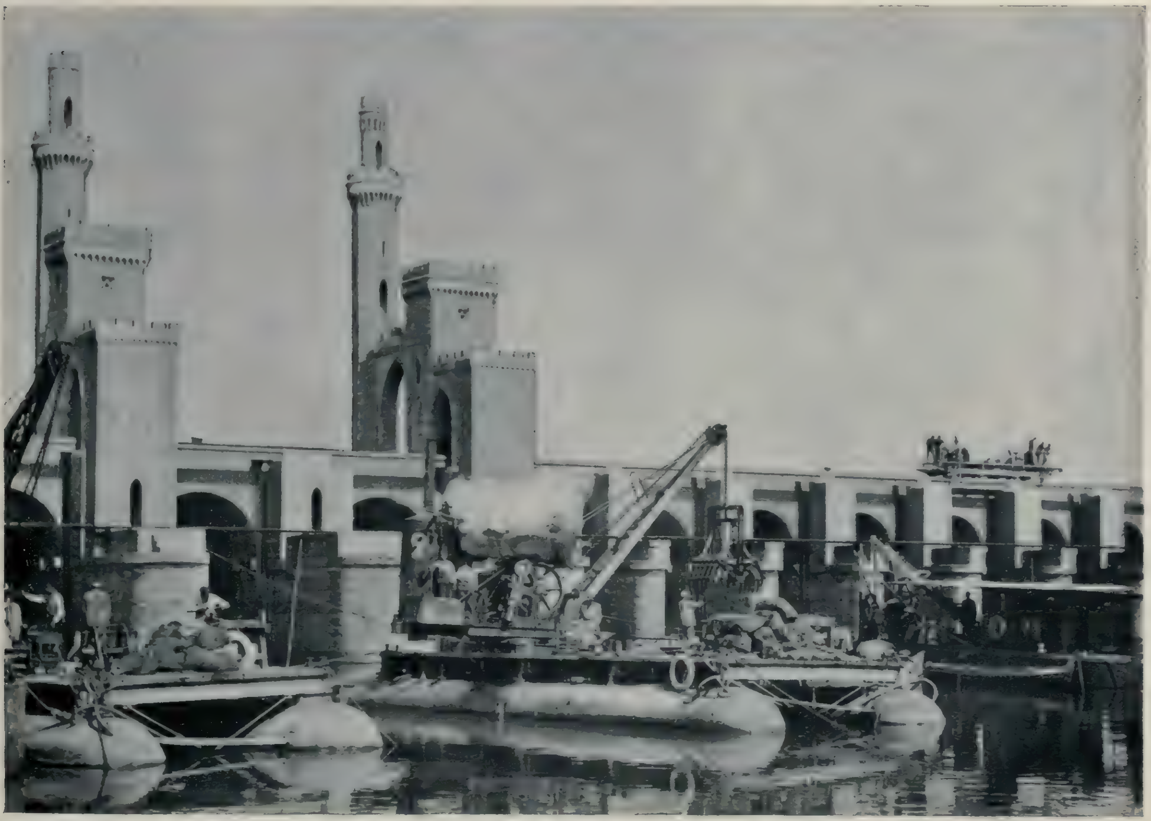
IN small dredgers for harbour and dock work, and for clearing rivers, canals, and various waterways, the form of the bucket, or grab, generally employed has attained to such perfection that it is at present not so much the tool itself, but the method of applying the necessary power to it that engages the attention of those interested in this particular class of tool.

For certain purposes, buckets, or grabs, of single-chain type, worked by a single chain, and capable of attaching to and working from an ordinary single chain-lifting crane, can be, and are to a certain extent, advantageously employed; but for all-round dredging or excavating, these single-chain grabs are open to various objections when compared with grabs of the double-chain type, worked from suitable cranes of special design and construction.

In the dredging operations at the lower Barrage, on the Nile, it was found advantageous to use the "Kingston" type of double chain grab dredger, made by Messrs. Rose, Downs, and Thompson, Ltd., of Hull and London. The accompanying illustration shows several of these handy and efficient machines in operation.

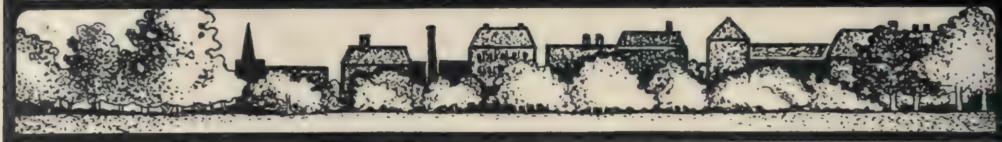
In the "Kingston" dredger all the wearing parts are in the machine itself and not in the grab, so that when dredging amongst heavy sand, shingle, etc., there are no intricate parts to become damaged or unduly worn. The grab is actuated by two chains. One of these opens it for a fresh lift, the second chain being worked from a small auxiliary winch—an advantage which renders the crane distinct from any other type. The driver has thus full control over both chains, and can instantly open or close the grab at will in the event of a mislift being made, or the grab closing on something which it is unable to lift. This is, of course, a matter of considerable importance when very stiff material is encountered, as it would give the grab a pecking or scraping movement, thus aiding the ultimate lift.

The machines illustrated are mounted upon double cylindrical steel pontoons, which are found to be most suitable for the particular work in question. The capacity of the "Kingston" varies between 30 and 500 tons per hour.



"KINGSTON" DREDGERS EMPLOYED ON THE RECONSTRUCTION OF THE LOWER BARRAGE ON THE NILE.

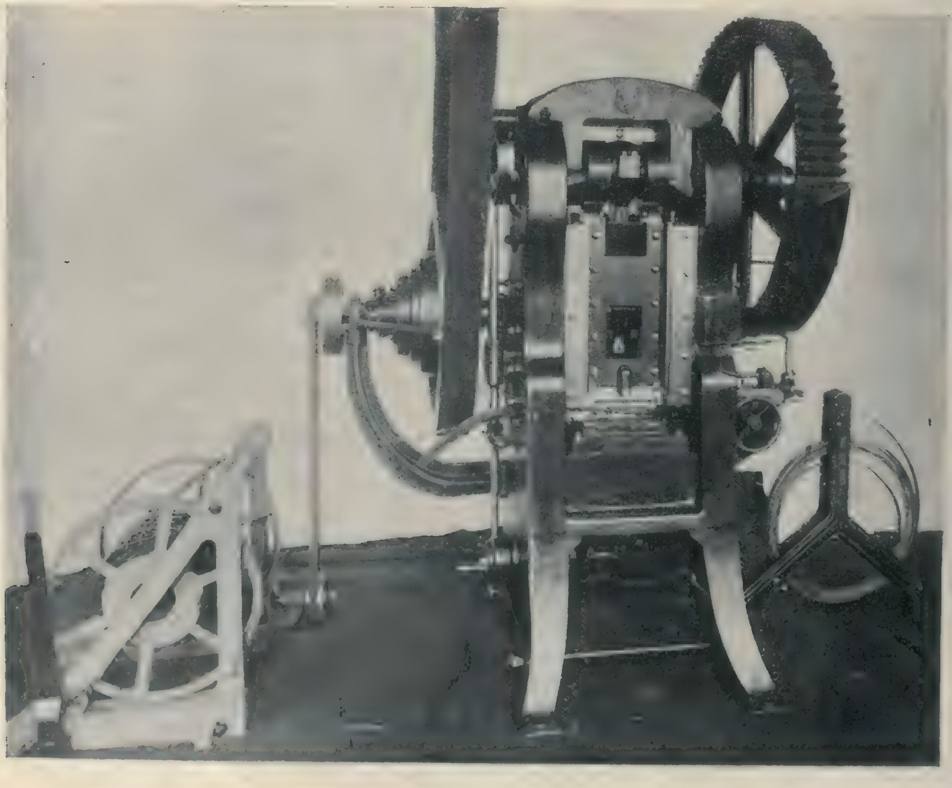
MODERN CHAIN MANUFACTURE.



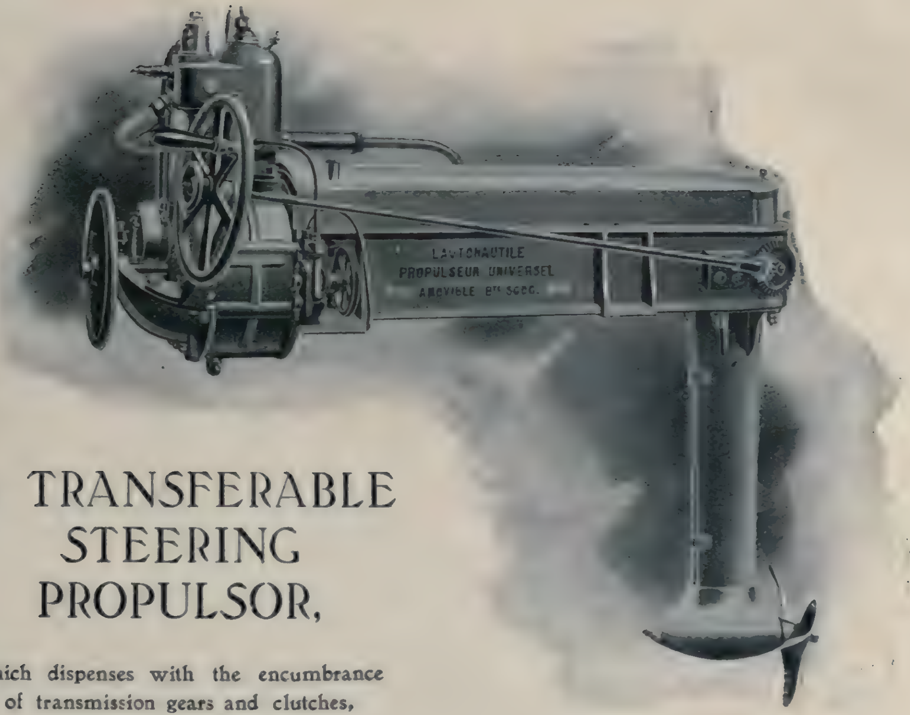
THE machine here illustrated may be described as a marvel in mechanics, for it is fed with hoop steel on the one side and disgorges finished chain of the "detachable" type on the other. Hitherto, detachable chain has been made only of cast-iron which had to pass through no less than seventeen different operations in the course of its manufacture, whereas the Locke Steel Chain is made by a series of five operations with a series of ingenious dies. It is impossible within the space at our disposal to follow the intricacies of the process; suffice it to say that instead of taking the chance product of castings, the Locke chain is scientifically made—both in construction and composition it is altogether subject to control. For instance, links can be made to detach easily or with difficulty, and may be produced of any design or strength.

The soft steel after being made into chain is hardened and tempered by a special process, rendering it proof against the jerks and jars that are so liable to break chains in actual work.

The Locke Steel Chain Company, of 18, Bishopsgate Street Within, have acquired the entire European patents connected with the invention, and have erected a factory at South Tottenham for the manufacture of the chain.



AUTOMATIC MACHINE TURNING OUT FINISHED CHAIN FROM A BAND OF HOOP STEEL.



A TRANSFERABLE STEERING PROPULSOR,

Which dispenses with the encumbrance of transmission gears and clutches, reversing gears and rudder.

A NOVEL apparatus for propelling and steering boats is the Universal Transferable Steering Propulsor illustrated herewith, its most interesting feature being the gyratory movement of the screw-box through the entire arc of a circle, which enables the helmsman to turn the boat within its own length. Economy of working and maximum speed are also claimed for the apparatus, which, we understand, is already used in the navies of France, Russia and Japan. The apparatus comprises a motor with special carburettor, a horizontal frame, vertical arm, and the screw-box and screw, movable around a vertical axis. The motor acts directly upon a shaft passing through the horizontal frame, which in turn, by a system of gearing, transmits to a vertical shaft enclosed in the vertical arm, and thence communicates to the screw the rotary motion necessary for propulsion. The screw-box is kept in position at the lower extremity of the vertical arm by a movable tube passing through the arm, the upper portion of the tube ending in a pinion controlled by a shaft passing outside of the horizontal frame, to which the steering-wheel is attached.

In this way a gyratory movement is given to the screw for steering purposes, and it can be turned horizontally in any direction.

Numerous applications for such a device suggest themselves in connection with life-saving, commerce, or pleasure boats, and not the least important feature of the apparatus is that it can be transferred from one vessel to another.

Being independent from the hull of the boat, the propulsor does not transmit the motor's vibrations, and, consequently, the resulting strains on the ribs of the boat are small, while, as the apparatus occupies a minimum of space, *the whole of the boat is available* for passengers or cargo.

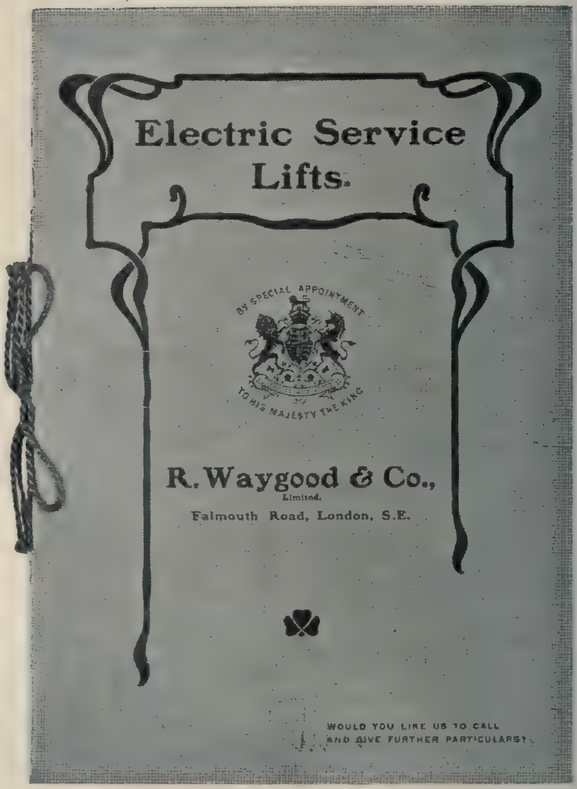
For the illustration and particulars we are indebted to Mr. W. R. B. Lockie, of Liverpool.

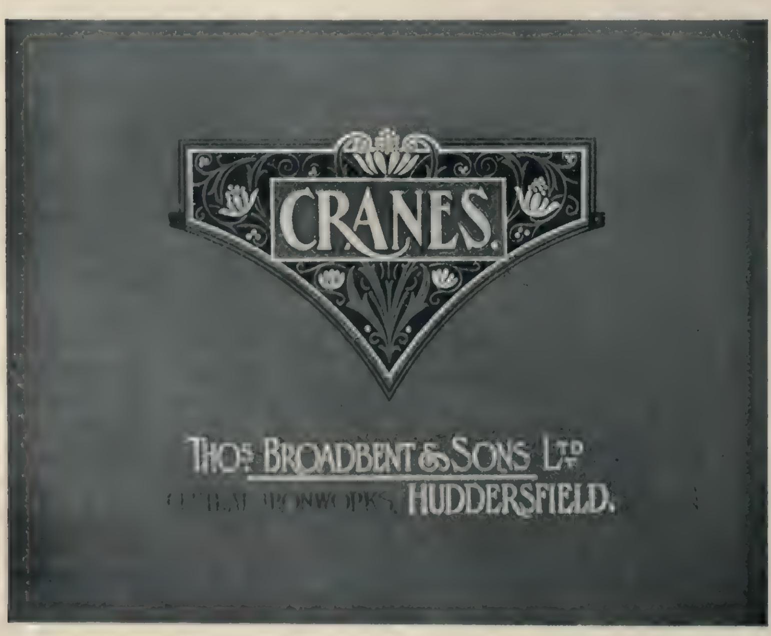
CATALOGUE DESIGNS . . .

SOME attractive cover designs are illustrated this month, though as colour plays a very important part in both, we are unable to do full justice to the originals.

One of the most tasteful designs we have seen lately is forwarded by Messrs. R. Waygood and Co. The line work is forcible without being redundant and is executed in dark green, upon a most ingenious background made up of cross-hatching. The royal arms appear in red, which colour is also chosen for the dainty silk bow with which the brochure is tied. The interior is in keeping with the clever cover, the text being printed in red type, while the half-tone blocks are of the best.

We are reviewing Messrs. Broadbent and Sons' latest effort in another part of the Magazine.





This collection of admirable views is bound in a highly artistic cover for which a subdued shade of green has been chosen. The wording and lighter parts of the design appear in mat silver and are thus thrown into high relief. The darker part of the cover is produced in electric blue and metallic purple, which gives an exceedingly rich *tout ensemble* to the cover. The interior is elegantly printed on the finest art paper.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel Mining and Allied Industries.

DAVIDGE PAGE, Editor,

Clun House, Surrey Street, Strand, London, W.C.

Telephone No: 3349 GERRARD.

Telegraphic and Cable Address: "SINEWY, LONDON."

Editorial.—*All communications intended for publication should be written on one side of the paper only, and addressed to "The Editor."*

Any contributions offered, as likely to interest either home or foreign readers, dealing with the industries covered by the Magazine, should be accompanied by stamped and addressed envelope for the return of the MSS. if rejected. When payment is desired this fact should be stated, and the full name and address of the writer should appear on the MSS.

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OUR MONTHLY SUMMARY.

LONDON, March 22nd, 1904.

Our Navy.

The war in the Far East has already provided us with an object lesson on the value of an efficient navy which can scarcely fail to have impressed those who are inclined to grumble at our rising navy estimates. Efficiency unquestionably is the keystone of the policy which governs at the Admiralty to-day, and while this is so, Britain can certainly afford to pay and pay handsomely for all that the navy means. The estimates for 1904–05 provide for an expenditure of £36,889,000, which means an increase of £2,432,000, part of which is accounted for by the larger part of the cost of the *Triumph* and *Swiftsure* being debited to next year's account.

The ships at present under construction include eight battleships, thirteen armoured cruisers, one second-class cruiser, four third-class cruisers, eight scouts, twenty-three destroyers, eleven submarines, a river gunboat, and the new Admiralty yacht. Two battleships, four armoured cruisers, fourteen destroyers and ten submarines will be commenced during the financial year 1904–05. The acquirement of the Chilian battleships has necessarily modified last year's programme so that only two new battleships will be laid down and these will be commenced in the autumn instead of in April. They will be known as the *Lord Nelson* class and will be the first of a new type of warship, with very heavy armament.

Steady progress has been made with the work of reconstruction announced two years ago, and in the current year steps have been taken which will greatly increase the efficiency of the dockyards which are to be completely furnished with electric light and power, while the obsolete machinery of which we have heard occasional complaints is to be replaced with appliances of the latest type. It is also very satisfactory to know that in no country have more careful experiments been made with regard to the utilisation of oil fuel in the navy.

The Best Guarantee of Peace.

Our position with regard to the Navy was well put by Sir George Sydenham Clarke, K.C.M.G., R.E., in a paper which was printed by the order of the Victorian Senate in June last, and, in view of subsequent events in the East, it is doubly interesting at the present moment.

"Great Britain," said Sir George, "has a distinct superiority in battleships and in cruisers over the two next Powers. In first-class battleships completed we shall next year be equal to any three Powers. Our total naval expenditure is now nearly equal to that of France, Russia, and Germany combined, and we can build warships more quickly and more cheaply than any of these Powers. The important alliance with Japan would, in certain contingencies, bring seven battleships and thirty-three cruisers, all concentrated in the China seas, into line with the British Navy, and no European fleet is more efficient in proportion to its numbers, or manned by better fighting men than that of Japan. A feverish naval competition still continues, and is most marked in the case of Germany and the United States, while Japan has lately had the patriotism to lift her Navy out of the sphere of party politics. France of late slackened somewhat in building battleships especially, but is now building six of the first class; Russia continues steadily to increase both battleships and protected cruisers.

Position of the British Navy.

"I consider that our present position is satisfactory Both absolutely and relatively, to probable enemies, the British Navy has never been so strong, or so efficient in peace time as it now is; but this result has been attained only in recent years, and by strenuous efforts. During last century there were periods of dangerous weakness. We had ignored the plain lessons of our history; we lived upon the prestige of the past, and we courted disaster. There can be little doubt that our marked efforts since 1889 to build up the Navy have stimulated a competition which would not have become so acute if we had maintained a consistent policy. Our naval estimates have been doubled, and their present amount, more than £34,000,000, exclusive of India and the Colonies, must throw strain upon our resources, especially as we have not yet adapted our military organisation to our real requirements, and our normal Army expenditure has mounted up to more than £27,500,000, not including the cost of over 70,000 Regular troops serving in India. In view of these enormous figures, I think that you will agree that the mother country is fully alive to her vast responsibilities, and is making splendid efforts to maintain that supremacy at sea which is the surest guarantee of peace, and which in war is the only means of guarding the commerce upon which the Empire, and most especially Australia, absolutely depend. On two recent occasions, at the time of the Fashoda incident, and during the critical period of the South African campaign, the Navy stood directly and effectually between the nation and a great war.

"There are some persons who seem to find pleasure in discovering special sources of danger to the Empire, and you may have been told that the sea is an 'unstable element,' that naval operations are, therefore, uncertain, that changes in ship-building and in armaments have operated to our disadvantage, and that the lessons of the past are valueless in view of the unknown conditions of the future. I ask you to reject unhesitatingly all such suggestions. Our history proves conclusively that, while the land has proved too frequently treacherous, the sea has been our constant ally, always faithful except when we have neglected its claims."

The Submarine Tragedy at Portsmouth.

During the month the loss of the submarine *A* 1 with all on board under such tragic circumstances has cast a gloom over Portsmouth, and, indeed, throughout the length and breadth of the land, from His Majesty the King, who recently inspected the submarine, to the humblest colleague of the gallant men who died at the post of duty. For anything approaching this terrible affair we have to go back to the attack on the *Housatonic* in the days of the American Civil War when, as told by Mr. Burgoyne in his fascinating work on submarines, the attacking submarine *David* became wedged in a hole in the side of the doomed warship and the nine men who formed her crew were drowned. The dangers of submarine warfare, even in times of peace, are only too obvious. The wonder is that, in the development of the submarine, disasters have not been more frequent. The sad affair at Portsmouth will, no doubt, be the subject of a searching inquiry. At the moment we can only join in respectful sympathy with the bereaved.

Invention without Incentive.

Mr. George Archibald Lowry complains bitterly in the "Society of Arts Journal" of the condition of our Patent Laws, in which he remarks there is neither encouragement, hope, nor incentive for the inventor. Your patents, says Mr. Lowry, convey no sense of ownership nor evidence of the applicants having invented anything. It is simply a certificate of registration of the application, drawings, and claims, and that they conform to the requirements of the office.

To give a patent any tangible or marketable value, it must first be fought through the courts to a decision in its favour—even if the inventor's means should permit him to do so, and he should live to see the end of the litigation, the term of his patent would probably have expired, or been materially reduced—and if he is defeated in even one claim, though he has fifty others that are good, his whole patent is declared invalid.

The English investor asks first, "Have you a United States or German patent?" Unless you have one or both of these the English patent carries no weight and his interest ceases.

Is it justice to your inventors that they must seek from a foreign country protection in their own—these foreign patents are practically a guarantee that "you are the sole and original inventor of a new and novel device"; those who wish to invest feel safe, and those who infringe do so at their peril.

Your Government has not even the excuse of "expense," for although the United States Patent Office fees are only forty dollars (£8) the office is now over two million dollars ahead of its outlay. It would not cost Great Britain anything to protect her inventors—but instead of doing so she and her Colonies prey upon them. The inventor is made a source of revenue—to cover the simplest device with patents "under the Flag," and pay the taxes, costs over a thousand pounds.

Another correspondent of the "Society of Arts Journal" expresses the hope that Mr. Lowry's complaint may approve the starting point for a reconsideration by the Society of Arts of the whole question of British Patent Law.

Accidents to Workpeople in 1903.

The Board of Trade returns show that during the past year 4,153 workpeople were reported as killed in the United Kingdom by accidents that occurred in the course of their employment. This number shows a decrease of 170 (or 4 per cent.), as compared with 1902, and was lower than in any year since 1898. An analysis of the figures for 1903 shows that the 1,380 seamen killed by accident included 920 employed on steamships, and 460 on sailing vessels. These figures give 1 death for every 223 persons employed on steamships, and 1 for every 93 employed on sailing ships. Wrecks or casualties to the vessels accounted for 622 out of the 1,380 deaths. Of the 1,097 deaths among miners, 1,072 occurred through accidents at mines under the Coal Mines Regulation Acts, and of these, 567, or more than half, were occasioned by falls of roof or side. The returns of fatal accidents to railway servants show that of the 459 killed in 1903, 94 were permanent way men, 49 porters, 37 shunters, 34 brakesmen and goods guards, and 245 in various other occupations. Among the 742 factory workers killed, the greatest number of deaths in any one group of occupations was in the founding and conversion of metals, viz., 107, followed by 90 in ship and boat building, 65 in textile factories, and 48 in the extraction of metals.

Improvements in the Reciprocating Engine.

A good deal of attention was given to the question of superheating by Mr. John Mills, in the course of a paper on Improvements in the Working of the Steam Engine, read before the Staffordshire Iron and Steel Institute. Superheating is a subject which, in the opinion of Mr. Mills is destined to receive more and more consideration. He remarks that if a superheater can be brought into the market that will, as Professor Watkinson states his will do, last as long as the boilers to which it is connected, and will be free from the defects of most types hitherto in use, superheating will, no doubt, be more generally adopted; for in this direction lies the chief future economy in the working of the best designed up-to-date engines of the present day. The economical improvements in the reciprocating steam engine are found to be, chiefly, increased piston speeds, the use of higher pressures in (1) the single cylinder, (2) in the compound engine, and (3) in the triple and quadruple engines; great reduction in the clearance spaces, improvements in the proportioning for the pressure and work to be done in multi-cylinder engines, and the use of superheated steam. Whether the reciprocating engine, with all the improvements applied, has reached the zenith of its usefulness, and is to be superseded by the gas engine using producer, furnace or other gas—or that the rotary engine (as some of the prophets say) will in a short time oust both—Mr. Mills does not pretend to say. In his opinion, the reciprocating engine will not be scrapped just yet. "Threatened lives live long."

More about the Proposed Thames Dam.

We hope to give more attention in an early number of PAGE'S MAGAZINE to the proposal of Mr. T. W. Barber, M.Inst.C.E., to construct a dam across the Thames at Gravesend, as briefly outlined in our March issue.

Of course, many objections are likely to be encountered in the furtherance of this scheme. For instance, a correspondent in the "Times" wants the following questions answered:—

(1) What will be the effect upon the climate of London and the health of its citizens of a huge and, comparatively speaking, stagnant lake of fresh water set in their midst?

(2) Is not the present constant passage to and fro of salt-water tides through the heart of our city, with the currents of sea air that always go with the ebb and flow of the tide in a river channel, one cause of the comparative good health of Londoners?

(3) Will winter fogs, our worst climatic enemy, decrease or grow worse by reason of this great London pool?

(4) Will the more or less dead waters of the said pool, containing, as they will, the accumulated sewage outflow of the up-river towns, with so much of that of London as is not carried down Thames, be so very clear and clean as the promoters of the scheme contend?

To these questions Mr. Barber replies categorically as follows:—

(1) The effect of a fresh-water lake upon health and climate of London will be wholly beneficial by (*a*) the abolition of mud banks; (*b*) the removal of the polluted zone of the river—now extending from Richmond to Erith—far below London, that is, from Woolwich to Greenhithe; (*c*) the conversion of a mixed, muddy, rapid stream into a quiet, fairly clear, slow-moving lake of fresh water; (*d*) keeping the river always full. There will be no more stagnation in the Thames lake than in other lakes.

(2) The "constant passage to and fro of salt-water tides, with the currents of sea air that always go with the ebb and flow," etc., is a pure myth. The salt water interferes with and retards the natural purification of the river, and the sea air has no existence in the Thames valley except in imagination, for the wind "still bloweth where it listeth," tide or no tide.

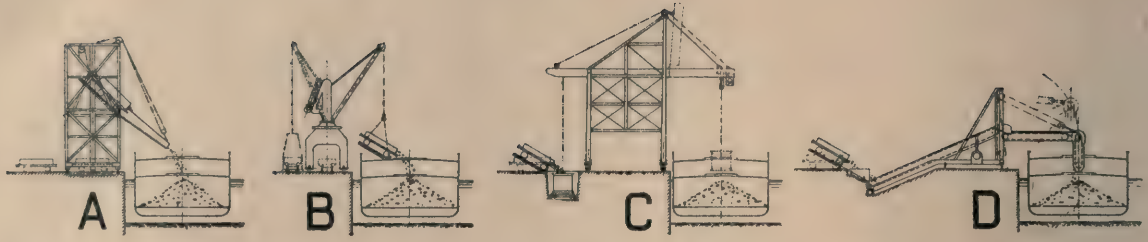
(3) Winter fogs.—If the opinions of all river people are correct, that fogs come up with the tides, the dam should effect an improvement in this respect.

(4) "Accumulation of sewage in the dead waters of the lake," etc. There will be no dead waters, and sewage does not accumulate in a river or lake; all rivers purify themselves of organic pollution by natural bacterial oxidation. Drs. Debdin and Dupré have both shown that the Thames has ample upland water to oxidise all its pollution, which is even now effected before it reaches Gravesend, and will be more rapidly effected when the tides are kept out.

Mr. Barber also remarks that the proposed dam would provide the best possible security against foreign invasion *via* the Thames, as it could be easily fortified. Tilbury Fort, which dominates it, would become a valuable military asset.

The National Physical Laboratory.

The report of the National Physical Laboratory for 1903 contains full details of the work which was carried out during that year, and also an outline of the programme for the present year. In the engineering department this includes a continuation of the research on wind-pressure and of that on the mechanical properties of nickel-steels, undertaken jointly with Mr. Hadfield; an inquiry into the specific heat of superheated steam on a large scale; the erection and testing of the new screw-cutting lathe, for which a special house has been built, and which is to be used for making standard leading screws on behalf of the Standard Leading Screw Committee of the War Office; and the construction of a machine for determining the friction of bearing surfaces. In the physics department, among other things, the construction of a standard ampere balance, together with various electrical tests, is to be undertaken for the Engineering Standards Committee; various methods of measuring temperatures between 1,400° C. and 1,800° C., and the suitability of different glasses for high temperature thermometry, are to be investigated; the standardisation of the steel yard and nickel metre is to be completed, and the urgently required work of comparing an "end" yard and an "end" metre with the "live" standards and of calibrating the sub-divisions of each is to be undertaken; and an inquiry is to be initiated into the conditions in which the pentane lamp may be treated as a standard, and measurements made of the refractivity and absorption of various glasses used by opticians. During last year 1,330 tests were made in the engineering and physics departments. The receipts for 1903 were £10,200 and the expenditure £10,306, the deficiency thus being £106. The committee holds that an increase of funds is necessary even to maintain the work as at present, and a further increase if work for which there is a demand is to be carried out. It also thinks that, for the sake of permanence, the positions of the senior members of the staff should be made more secure, and that the stipends now paid to the assistants—with one exception £200 a year—are not commensurate with the work and are insufficient to retain for long the services of suitable men, while in addition, the staff is now too small.



WAGON LIFTED IN ELEVATOR WAGON HOISTED BY CRANE SKIP SYSTEM – FULL WAGON LOAD ENDLESS CHAIN AND BUCKET

THE CIVIL ENGINEER AT WORK.

By C. H.

The Mechanical Shipment of Coal.

" The Mechanical Shipment of Coal : a brief account of some of the principal systems in use in Great Britain and other countries, with a note on the system recommended for the Calcutta Docks "—such is the title of a work that will be found of great interest by all engineers who are in any way connected with the shipment of coal. The author is Mr. E. Herbert Stone, M.Inst.C.E., Chief Engineer of the East Indian Railway, and the work, which is published at the Bengal Secretarial Book Depot, can be obtained of Mr. Arnold, Messrs. Constable and Co., and several other officially appointed agents. The greater part of the coal exported from Bengal is shipped from the Kidderpore Docks, Calcutta, and it has been found necessary to give very careful consideration to the different systems of mechanical shipment with a view to the provision of a permanent installation. The author has included a valuable collection of notes, drawings, and photographs, which should serve to elucidate the problem.

To meet the conditions and requirements laid down, the four systems considered most suitable are as illustrated above, viz. :—(*a*) Wagon lifted in elevator and tipped into shute, as at Barry, Newport and elsewhere ; (*b*) wagon hoisted by crane and slung over ship, as at Glasgow, Fleetwood and elsewhere ; (*c*) skip system ; (*d*) endless chain and bucket system.

It will be understood that for (*b*) and (*c*) systems either a radial jib crane or traverser crane may be used, whichever may be considered more efficient. System (*a*) is finally preferred, on the grounds of economy and efficiency. The rate of working possible on this system is about one minute per tip, approximately as follows : (1) Lift (loaded), 30 seconds ; (2) tip, 10 seconds ; (3) lower (empty), 20 seconds. Total, 60 seconds. With wagons holding twenty tons, this would give a possible delivery of about twenty tons per minute, or 1,200 tons in an hour.

The author remarks that against system (*a*) it has been stated that it is more liable to cause breakage of the coal than would be the case with skip systems or chain and bucket systems, under which the coal is deposited in the hold of the ship with a minimum of fall. But with the anti-breakage boxes (now in general use with the elevator system) this breakage is much reduced, and with the coal to be dealt with in Calcutta it does not appear likely that there would be more difficulty in this respect than in South Wales, where this system is preferred.

Mechanically, system (*a*) is in all respects an excellent one. The load is dealt with direct and in the most efficient manner, the arrangement being such as enables the requisite strength and lifting power to be secured to the best advantage. The result is that the machine will deal with larger loads at a lower cost, and with greater speed than other machines not having these advantages.

Civil Engineers in Conclave.

An International Engineering Congress, under the auspices of the American Society of Civil Engineers, will be held at the Universal Exposition, St. Louis, Missouri, U.S.A., during the week of October 3rd to 8th, 1904. As a basis for discussion at the sessions of the Congress, the Committee has invited engineers specially qualified in each of the various branches to prepare a review of the development during the past ten years in that branch in the United States, together with a summary of present practice. Engineers in other countries, experienced in these various lines, will be specially invited to prepare similar papers presenting a review and summary of practice in their respective countries. It is proposed to print these papers in advance, in order that a full discussion at the various sessions may be elicited without giving up any time to the reading of papers at the congress. All engineers in the United States and in all other countries are invited to become members of the congress, to attend the sessions, and to take part in the discussions ; or, if unable to attend, to forward written communications on any of the selected subjects. It is not expected that delegates will be formally appointed, it being intended that an opportunity to attend shall be afforded to any who may wish to become members of the congress. The following are included in the list of subjects :—

Natural and Artificial Waterways ; Lighthouses and other Aids to Navigation ; Traffic on Improved Waterways, as Compared with Seaboard Traffic, and the Effect of this Development on Railroad Traffic ; Purification of Water for the Production of Steam ; Turbines and Water Wheels ; Railroad Terminals ; Underground Railways ; Locomotives and other Rolling Stock ; the Substitution of Electricity for Steam as a Motive Power ; Disposal of Municipal Refuse ; Ventilation of Tunnels ; Passenger Elevators ; Pumping Machinery ; Steam Turbines ; Electrical Power—(*a*) Generating Stations, (*b*) Transmission ; Mining Engineering ; and Engineering Education.

Obtaining the Best Results from Concrete.

At a recent meeting of the Society of Engineers a paper was read on " Some Recent Works of Water Supply " at Penzance," by Mr. Frank Latham, M.Inst.C.E.I., Borough Engineer and Surveyor, Penzance. The author described in detail the construction of the service reservoir, which was built on the Hennebique Ferro-Concrete system, and was the first reservoir constructed under the Hennebique patents to receive the approval of the Local Government Board. Particular stress was laid upon the care and knowledge required in selecting materials and putting them together in order to obtain the best results from concrete. He remarked that the too common practice of entrusting this kind of work to inexperienced persons, with the notion that concrete making is but a matter requiring ordinary intelligence, chiefly in that the proper quantity of cement is used, is most erroneous, and calculated to court disaster. Having recently made scores of briquette tests, he has not infrequently found that a practical gauging with less cement will give a higher result than an inferior gauging with a greater proportion of cement.

The author made ten briquettes from material taken from the works of the Penzance sea wall. In some cases the materials were carefully measured in accordance with the stereotyped specification: 1 of cement to 4 of sand, etc.; and in others, care and judgment were used, placing a little finer sand to the mixture and a larger proportion of sand to fill up the voids in the gravel. These briquettes were proportioned 1 to 4, as in the case of the others, also 1 of cement to 7 of aggregate, and the result was that the 1 to 7 briquette stood 115 lb. tensile strain, and the other stereotype mixing in the proportion of 1 to 4 stood but 45 lb. after twenty-one days' immersion in water in each case. On examining the careful gauging of 1 to 7, and comparing it with samples containing a higher percentage of cement, it was to be observed there was the appearance of excess of cement showing on the top trowelled surface of the former, and insufficient cement in the latter, although the proportions in which the cement was actually used were the reverse.

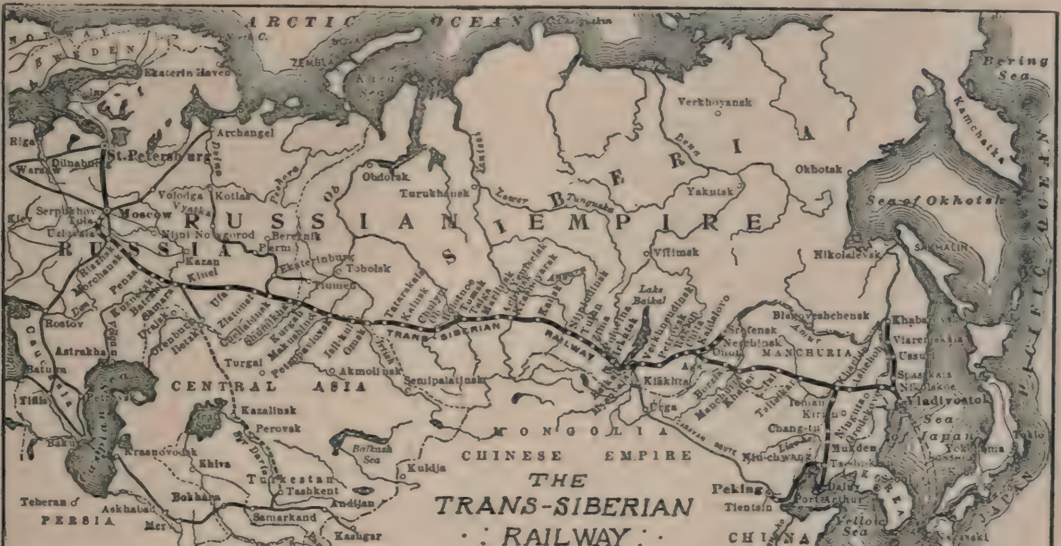
Railway Progress in Switzerland.

According to a "Times" correspondent, two rival projects are at present being discussed in Switzerland for a new railway to pierce the Alps and extend communication with the north of Italy. One is by way of the Greina, which would emerge in the Canton of Ticino, some 20 kilometres (12½ miles) east of the Gothard route, and, as its advocates maintain, lie almost entirely on Swiss soil. The other route proposed would pass under the Splügen, by a continuation of the Chur-Thusis railway, and would, it is maintained, develop the rich country south of Chiavenna in the province of Como, by bringing it into closer connection with East Switzerland and southern Germany. In either case, an eastern Alpine railway lying between the Gothard and the Brenner routes cannot fail to become of international importance. A third railway project, which has just been approved by the international experts, is to connect Berne with the Rhone Valley and the Simplon route, by a line running due south from Berne through the Wildstrubel into the Canton of Valais. The longest tunnel is to be 8½ miles, and the time of its construction 4 to 4½ years. This would do away with the roundabout journey from Berne *via* Lausanne into the Rhone Valley, and create a direct international route from Paris to the Simplon.

The Cape to Cairo Railway.

Reuter's Agency is informed that the Cape to Cairo Railway will reach the Zambesi at the Victoria Falls in the course of next month, and that the first through train from Cape Town to the Zambesi will run in April or May. On February 1st the rails were within forty-eight miles of Victoria Falls, and excavations for the great bridge which is to span the Zambesi were in active progress. The first portion of the bridge work is now on its way to South Africa, and will be followed by the remaining sections as rapidly as possible, so that the erection of the bridge may be completed this year. With the setting up of the bridge and the completion of the line to that point the present contracts expire.

The next section of the line to be built will be from the Zambesi north-east to Broken Hill, a distance of 350 miles in the direction of Lake Tanganyika.



Under favourable circumstances the Trans-Siberian Railway should bring London within nineteen days of Japan. The actual distance to Port Arthur is 7,367 miles. The construction of the Chinese Eastern (Manchurian) Railway was described in PAGE'S MAGAZINE of July, 1903.

SHIPBUILDING NOTES.

The Shipbuilding Quarter.

By the time these lines are in the hands of the reader we shall have reached the end of the first quarter of the shipbuilding year. The quarterly totals, of course, are not available as we write, but we have sufficient information to show that the output has been considerably short of the corresponding portion of 1903. And the trouble is, as far as the industry is concerned, that month by month the comparison with last year will now become more and more unfavourable. This is not surprising from the point of view of the shipowner, who well knows how unprofitable shipping has been for the last year or so; but in practice the shipyard does not care whether the steel work or the ship is making money, so long as it has plenty of employment for its own hands. And that is what it has not at present, nor is likely to have this year, although one may reasonably infer that the war in the Far East will by-and-by cause some changes in the industrial conditions. One must remember that the engagement of most of the merchant fleet of Japan in warlike services, and the retention of the Russian Volunteer Fleet by the Russian Government, have caused gaps in the streams of ocean carriers which must be filled up somehow. Nor can the war pass over without considerable damage to the merchant shipping of the belligerents, and detention of that of neutrals. What we mean is that the war will probably cause some improvement in freights, which will incite British shipowners to order more vessels—especially if there is (as is probable) some demand for second-hand ships for transport. But this is a prospective effect, which cannot be felt for some time.

The Districts.

It is true that there has been considerable improvement in the North of England shipbuilding districts since the beginning of the year, and that the improvement there has served to better the Clyde district. But after all, the new contracts which have been announced do not extend to all the yards nor fill up any of them. There are a few yards, especially those with Admiralty and liner work on hand, which are very well employed, and which regard the future with complacency. But there are very many with very little on hand, and with nothing to look forward to. Moreover, the merchant work which is being booked by shipbuilders just now cannot be on remunerative terms—there is so much cutting when specifications are submitted. Shipbuilders are neither more greedy nor more generous than their neighbours, but like most large employers of labour, they deplore seeing their men put out of employment. To keep their hands together and their plant employed they are willing enough at times to sink all considerations of profit. In fact, it is extremely doubtful if any recent contract for merchant craft will cover the standing charges in addition to labour and material, and it is highly probable that many of the contracts will leave a dead loss. Unfortunately for shipbuilders, material has gone up, although wages have gone down to a partial extent. In Scotland, for instance, the steel makers have combined to put up steel ship plates to £5 15s., less 5 per cent., with angles and other material in proportion. And they have bound themselves under heavy penalties not to sell below the prices fixed in combination in either Scotland or Ireland. This might afford an opportunity to English makers to dump in the Scotch markets, but the English makers are kept occupied with local orders, and do not need to go across the Border at present. Moreover, a strong attempt is being made to bring the English makers into the combination.

Material and Wages.

As ship plates were selling previously as low as £5 net, if not lower, it will be seen that the changed position is very disadvantageous for the builders. Those who accepted contracts on the £5 basis are bound to suffer, if they did not cover their material at the time. On the other hand, they will save a little in wages. Since January 6th the "black squad" in the North-east of England have been working on a reduction of 5 per cent. on piece rates, applicable to all the iron workers. Equivalent reductions proposed to the A.S.E. men and machine workers were rejected by them, and the employers decided to defer the matter for six months, as a little spurt of new business had set in since they proposed the reduction. In Scotland the 5 per cent. on ironworker's piece rates has been in force only since February 26th, and the engineers and machine workers have not been interfered with at all. But it is evident to the dispassionate observer that wages in the shipbuilding industry will soon have to be dealt with by a broad and firm hand. The reward of labour in the industry is far beyond its intrinsic value, and the development of almost supernatural machine tools is working a silent revolution.

Warship Building.

The leading features of the past quarter, then, have been the peaceful reduction of wages to a small extent, the advances in raw material, and (towards the close) a slight improvement in the demand for new ships. But the most striking feature has been the adoption of the turbine motor for ocean liners—first by the Allan line in the *Victorian*, now building at Belfast, and the *Virginian* now building on the Clyde, and second, by the Cunard Company, who have ordered a turbine engine to be put in the 12,000 ton ship to be built by John Brown and Co., Ltd., at Clydebank as a sister ship to the *Caronia*, now being built by that firm. The monster fast steamers have not been contracted for up to the time of the present writing. There is a good deal of disappointment in shipping circles at the Naval programme submitted to Parliament this year, because as the result of the purchase from the Chilian Government it has reduced the amount of contract construction work in the fiscal year now before us. The reduction, however, is not general, for while the amount to be expended on the Clyde contracts is £1,982,000, as against £2,827,000 last year, that on the Thames £970,000, as against £1,645,000, that on the Mersey £495,000, as against £893,000, that at Belfast £193,000, as against £229,000, and that at Cowes £116,000, as against £130,000; the amount to be expended on Tyne contracts is the same as last year, £1,860,000, and that on Barrow contracts is more, viz., £1,575,000, as against £1,303,000.

A New Clyde Cruiser.

An interesting feature at the beginning of last month was the launch by the old firm of Messrs. Scott and Co., Greenock, of the first-class armoured cruiser *Argyll*, as no vessel for the British Navy has been constructed by this firm since they built the gunboats *Sparrow* and *Thrush* fifteen years ago, although the connection between the Admiralty and Messrs. Scott and Co. dates back to the days of the wooden walls. The first-class battleship *Prince of Wales* was, however, engined by them, and has just been handed over to the Government. The contract for H.M.S. *Argyll* necessitated the provision of suitable berthage and crane accommodation. This was not available in the usual fitting-out harbour at Greenock, and Messrs. Scott undertook to supply these requirements in their own establishment. A large fitting-out basin has been made, which will be equipped with a 120-ton electric derrick crane, now in course of erection. The keel of the *Argyll* was laid in September, 1902, the first rivet being put in by the Controller of the Navy during a visit to the yard. The *Argyll* is one of the six armoured cruisers of the *County* class, the last of which—the *Devonshire*—will be launched from Chatham Dockyard in the course of a month or two. Her principal dimensions are:—Length, b.p. 450 ft.; breadth, 68 ft. 6 in.; depth moulded, 38 ft. 6 in.; mean draft, 24 ft. 9 in.; displacement, 10,700 tons; i.h.p., 22,000 tons; speed, 22¼ knots. The hull was in a very advanced stage of construction at the time of the launch, and the launching weight was consequently greater than in the case of any of the other cruisers of this class when put into the water. More than the usual amount of machinery was also on board prior to launching.

British Gains and Losses.

The net total addition to the steam tonnage of the United Kingdom in 1903 was 1,008,756 tons gross, and of sailing tonnage 34,595 tons gross—in all 1,043,351 tons gross. About 93·5 per cent. of the tonnage added to Lloyd's Register consists of new vessels, nearly all built in the United Kingdom. The additions by vessels transferred from foreign countries and from British Colonies to the United Kingdom amounted to 55,086 tons, or about 5·3 per cent. of the total. The gross deduction from the Register amounts to 626,422 tons. About 39 per cent. of the steam tonnage and 54 per cent. of the sailing tonnage were removed on account of loss, breaking up, dismantling, etc. The tonnage transferred to foreigners during 1903 was 300,474 tons. The steam tonnage deducted on this account is 250,436 tons, and the sailing tonnage 50,038 tons, or about 49 per cent. and 42 per cent. respectively of the gross deductions in each case. Some 74,931 tons were transferred to Italy, and 49,370 tons to Norway within the year, while Germany got 27,553 tons, Japan 23,350 tons, and Belgium 21,450 tons. In the main, the vessels transferred to foreigners were not of very recent construction; nearly 34 per cent. of the tonnage removed from the Register sold to foreigners was built before 1880, 59 per cent. before 1885, and 71 per cent. before 1890. In addition to the tonnage transferred to foreigners, 62,907 tons were transferred to British Colonies during 1903, as compared with 32,603 tons in 1902, and 59,296 tons in 1901. On the whole, during 1903 the steamers on the official Register of the United Kingdom increased by 319 vessels and 500,108 tons; while sailing vessels decreased by 113 vessels and 83,179 tons. The total number of vessels on the Register, therefore, increased by 206, and the total tonnage by 416,929 tons. During 1903, 618 new vessels of 1,099,249 tons were classed by Lloyd's Register. Of these vessels 573 of 1,053,640 tons were steamers, and 45 of 45,609 tons were sailing vessels. Practically all the tonnage classed was built of steel. Sailing tonnage, which formed 25 per cent. of the total tonnage classed in 1891, 30 per cent. in 1892, between 1 and 2 per cent. in each of the years 1899 to 1901, and 5·7 per cent. in 1902, forms 4·1 per cent. of the total classed in 1903. Of the tonnage classed during the year 900,599, or 83 per cent., were built in the United Kingdom. Among foreign countries, the United States of America, Italy, Germany and Holland contribute the largest amount of tonnage.

The Premium System and the Home Dockyards.

The Notice to Workmen, printed on the following page, is a reduced facsimile of a document which has a very important bearing upon the economic working of the dockyards. A covering note from the Admiralty states that it has been already placed in certain of the workshops in His Majesty's home dockyards, where the premium system is being introduced for trial. The experiment will be watched with the greatest interest, and is significant of the forward policy that obtains at the Admiralty. The ready co-operation of the men should be ensured by the concluding paragraph alone, which states that increased energy and industry on the part of the workmen, added to such improvements as may be adopted from their suggestions, and resulting in work being done in less time than hitherto, will immediately benefit them by increasing their "premium" earnings.

New Floating Coal Depot.

The floating coal depôt launched by Messrs. Swan, Hunter and Wigham Richardson, Ltd., from their Wallsend yard, and intended for the Navy, has a storage capacity of 12,000 tons—11,000 tons in hoppers and 1,000 tons in bags, its output being at least 500 tons per hour. The twelve Temperley transporters are carried on four travelling towers, and are worked by electrical machinery. They are capable of reaching 20 ft. beyond the side of the depôt, and of lifting coal to a point 33 ft. above water level.

ADMIRALTY,

27th February 1904.

NOTICE TO WORKMEN.

On March 14th, 1904, the Premium System of Payment for labour will be introduced in this shop. At first it will be applied to certain classes of machine work, and if satisfactory results are obtained, the system may be extended.

The system will enable workmen to earn, in addition to their ordinary weekly wages, extra remuneration for doing work in less time than the fixed time allowed for it.

The system may be briefly described as follows:—

When a piece of work is given out, a certain time, based on known times taken for similar work done on ordinary time in this shop, will be allowed for it.

This time allowance will include all the necessary time for obtaining tools and materials, preparing the machine and lifting and setting the work in or on the machine, any removal and resetting, change of tools, and removing work after completion.

If the work is satisfactorily completed in less time than the fixed time allowed for it, the workman becomes entitled to a premium varying in amount with the time saved.

If on the other hand he takes longer than the time allowed, he will still be paid his ordinary wages.

From this it will be seen that while the workman may increase his wages by his own individual effort, he cannot lose money by the introduction of the system.

Premium will be calculated as follows:—

The value of a "premium hour" will be considered to be 1/48th of the workman's weekly wages, and the amount of premium earned on a job will bear approximately the same relation to the ordinary wages due for the time taken to complete it, as the time saved bears to the time allowed.

To give an example:—

Suppose a man is given 48 hours to do a job and does it in 36 hours, he saves 1/4th or 25 per cent. of the time allowed, and accordingly will be credited with 25 per cent. of the time taken to do the job, which is 9 premium hours, so that

> A mechanic in receipt of 36s. per week, and whose "premium hour rate" would therefore be 9d., would receive 9 × 9d. = 6s. 9d. premium for this job in addition to his ordinary wages for the period worked.

Similarly:—

> A skilled labourer in receipt of 24s. per week, and whose "premium hour rate" would therefore be 6d., would in the example quoted above receive 9 × 6d. = 4s. 6d. premium.

A convenient way for the workman to calculate his premium is to multiply the time taken by the time saved, and divide the product by the time allowed, all times being taken in hours. This will give the premium in hours which, multiplied by the "premium hour rate," will give the amount of premium earned.

Or it may be stated thus:—

$$\frac{\text{Time taken} \times \text{time saved}}{\text{Time allowed}} = \left\{ \begin{matrix} \text{Premium} \\ \text{time.} \end{matrix} \right.$$

Taking the case already given:—

$$\frac{36 \times 12}{48} = 9 \text{ Premium hours.}$$

The time taken will be recorded to the nearest quarter of an hour.

In calculating the premium the time taken will include all the working hours from the time of commencement of a job up to the time of commencing the next job.

Overtime, and night and day shifts, will be paid for at overtime rates as at present, but will only count as ordinary hours in the calculation of the "premium."

Lost time, or absence without leave, will count in the time taken. Absence with leave will not be included in the time taken.

The working of the system will be as follows:—

Each workman on commencing a "premium" job will receive a "Job ticket," on which he will find a description of the work to be taken in hand, the date and time of commencement of the job, the time allowed for it, and other particulars as to ship or service, head of charge, &c.

On this ticket the Shop Measurer will fill in the daily time worked, and particulars of overtime, leave, and lost time, and when the job is finished the time of completion will be inserted on it to the nearest quarter of an hour.

The ticket is then to be returned to the Inspector, and if the man's next job is also to be executed on "premium," the time of commencing the new job will be the same as that of finishing the previous job.

As soon as possible after a job has been inspected and passed as satisfactory, the amount of premium earned on it will be communicated to the workman.

Premiums will be paid weekly on the Friday following the week in which they have been earned.

It is to be clearly understood that a "premium" is not earned until the finished work has been inspected and passed as satisfactory.

If a man's work when finished does not pass inspection he will receive no premium for that job unless he can make good the work in the time allowed, in which case he will receive the premium on any saving of time still remaining.

No premium will be paid on articles that turn out defective, on account of faulty material or other causes, during machining or other operations; but if one or more of several similar articles, for which a covering time allowance for the whole is given, should turn out defective, the workman will still receive any premium earned on the rest of the articles, the premium being calculated on the saving of time made on the reduced time allowance corresponding in proportion to the number of articles satisfactorily finished.

No allowance will be made in the time taken for stoppages occasioned by breaking of straps, stopping of driving machinery, or any other cause.

In cases where a job is stopped in order to undertake more pressing work, or for any other purpose, the workman will return his "job ticket" to his Inspector, and the date and time of return will be noted on it (this being the commencing time of his next job if a "premium" job). The time spent on the job up to the time of interruption will be counted as part of the time taken, and on reissuing the ticket, the time allowance will, if necessary, be so revised as to give the workman as fair an opportunity of earning "premium" on the whole job as would have been possible had the work not been interrupted.

As far as practicable, time allowances for definite operations will not be reduced after they have been once satisfactorily established and regarded as standards, unless a new method of manufacture necessitating a revision of the time allowance be introduced. But if an established or standard time is seen to be operating unfairly to the workman, it may be increased with the sanction of the Principal Officer of the Department.

As some of the work in the Department may not be deemed suitable to be done on "Premium," it is to be understood that a man may be required to work on "premium" or on ordinary weekly time rate as occasion and the work may require.

Apprentices will not for the present be employed on "premium" work.

It is hoped that the introduction of the Premium System will lead to the workmen taking an increased interest in their work, machines, tools, and equipment generally, and to keenness on their part in pointing out to their Officers where improvements may be made and time saved, resulting in better methods of work.

It is pointed out that increased energy and industry on the part of the workmen added to such improvements as may be adopted from their suggestions and resulting in work being done in less time than hitherto, will immediately benefit them by increasing their "premium" earnings.

By Command of their Lordships,

Evan MacGregor.

[illegible]

LOCOMOTIVE ENGINEERING NOTES.

BY

CHARLES ROUS-MARTEN.

The Great Western French Engine.

Some particularly misleading and grossly unfair statements have appeared in the daily press with regard to the new Du Bosquet de Glehn engine on the Great Western Railway. It was stated by a prominent London daily paper that "the French engine had proved a failure" for the "usually punctual Cornishman," when hauled by her, reached Bristol four minutes late. Now this was a gross perversion of facts. It is quite true that "La France" on that occasion did reach Bristol four minutes late, but I have the Bristol times of that train for the whole month, and I find that it was invariably late, usually from ten to fifteen minutes, though drawn by British engines of the newest standard type. I myself tried it during that period with the new engine "City of London," and got to Bristol not "four," but *eighteen* minutes late. And no blame attached to the British engines any more than to the Frenchman. The reason was simply that heavy repairs to road and bridges were going on at several points, which compelled all trains to slow down to walking pace for considerable distances. An engine, however swift and powerful, cannot with prudence or safety rush heavy loads at high speeds over bridges under repairs! The consequences would be worse than the loss of four minutes!

Actual Performance of "La France."

It will be reflected by most thoughtful readers that if "La France" failed in England after her twenty sister engines had invariably done such splendid work in France, there must be something very wrong indeed—not with the engine, but with the treatment she received. But, of course, there is not a syllable of truth in the tale of her alleged failure. Now let us see what she really did when tried on the best express in the regular service "without fear, favour, or affection"; with Burden, the Royal record driver at the regulator, and Inspector Smith, of Swindon, on the footplate as "consulting engineer." The train was the 3 p.m. ex-Paddington, which makes the "longest non-stopping run in the world," viz., Paddington-Exeter, 193¾ miles, in 3 hours 30 minutes, averaging 55·4 miles an hour from start to stop, in spite of having to slow down to ten miles an hour for a considerable distance through the sharply-curved Bath station, and round the still sharper bends along the Avoiding line, by which Templemead station and its innumerable risks of "blocking" are evaded. What happened was this: The train stopped at the entrance of St. David's station, Exeter, in 3 hours 23 minutes 14 seconds from London, or 6¾ minutes under booked time. Yet it had been *twice* stopped dead for signal, for 3 minutes 45 seconds in all, and badly slowed *ten* times beside—thrice to walking pace; so that the actual net time for the 193¾ miles was only 3 hours 2 minutes 30 seconds. Moreover, the speed was carefully kept down at all the points where it is usually highest, *i.e.*, down the Wootton, Box, and Burlescombe banks, which were descended without steam on, at a very quiet pace. That train, however, is not heavily loaded in the winter, and in this instance the weight behind the tender was about 160 tons.

The Return Journey.

"La France" returned next day on the corresponding train which is booked to leave Exeter at 12.7 p.m. and to go without stop to London in 3½ hours. In this case, however, the load was much heavier, consisting of ten of the heaviest eight-wheeled vehicles, one being a large dining car. Again, there were numerous slowings for repairs to bridges and roads, seven in all, involving a total delay of eleven minutes, and once more speed was carefully eased off down the banks, notably the Wellington incline, down which we ran without any steam on, and at a far lower pace than usual. Also from first to last we were in front of our booked time, and so could not "go ahead" without the certainty of checks by slower trains which preceded us. Nevertheless, we completed the entire journey of 193¾ miles in 3 hours 28 minutes 51 seconds inclusive, or in 3 hours 17¾ minutes, allowing for the delays, and this with a load of 275 tons behind the tender. Manifestly this was excellent work, although not equal to some of the performances on the other side of the Channel by the French sisters of "La France," which I have recorded in these columns. So she still has "a lot in hand."

A New Great-Wester.

It is understood that a lengthened competitive trial will be made between "La France" and a Great Western engine of the latest British type, and that the newest of all has been specially constructed with this view. She is numbered "171," and is named "Albion" — a rather felicitous designation, if she is to compete with "La France." I have had two recent opportunities of inspecting her at Swindon, and she undoubtedly is an exceedingly "likely" looking machine. Practically, she is a replica of No. 98, with higher steam pressure, and consequently a stronger boiler—stronger, I mean, in the sense of having thicker plates, and so being able to stand the enhanced pressure of steam. Like No. 98, "Albion" has a leading four-wheel bogie, outside cylinders 18 in. diameter, with a 30 in. piston stroke; six coupled wheels 6 ft. 8 in. in diameter, and 2,143 square feet of heating surface. But whereas No. 98 carries 200 lb. of steam pressure per square inch, "Albion" has no less than 228 lb., the same as "La France."

A Valuable Comparison.

This will enable an approximate test to be made of the long-vexed question whether the advantages claimed for compounding be in reality due to that method, or to the higher steam pressure employed by compound locomotives. I say "approximate," because as a matter of course the test could not be complete unless the two engines in comparison were identical, save in the one being compounded and the other not. As it is, the two engines differ in almost every respect save their steam pressure and the size of their coupled driving wheels, while of these latter the one engine has four, the other six. The cylinder treatment is curiously diverse. "Albion" having 18-in. cylinders, whereas "La France's" four cylinders would be approximately equivalent to two 22-in. cylinders were she a non-compound. On the other hand, while "La France's" cylinders are only 25¼ in. in length, those of "Albion" are no less than 30 in. long. So here are several points as to which account will have to be taken in comparing results.

A Second Alternative to Steam Dome.

While noticing Great Western novelties, I may mention one which so far does not seem to have attracted the attention it deserves. Hitherto it has been generally accepted as an axiom that a locomotive must take its steam from the boiler in one of two ways. It must either be taken by the regulator from the upper part of a steam dome or else it may be collected through a perforated pipe along the top of the boiler. It has always been practically assumed that by no other means could the steam be obtained in a sufficiently dry condition. For many years the Great Western, like the Great Northern and South-Eastern, adhered to the domeless boiler with the perforated pipe. Then, as in the case of those other railways it “ ’verted ” to the prevalent fashion of the steam dome. Latterly, it has once more *re*verted to the domeless boiler with the perforated pipe. But with the new so-called “taper” or “extended wagon-top” boilers, Mr. Churchward finds that he can adopt a third alternative, and take his steam from the highest point in the boiler in an amply dry state without the intervention either of the dome or of perforated pipe. The abandonment of the dome has become almost compulsory by the great height to which the latest Great Western boilers are raised; but its loss is not deemed a matter for regret, inasmuch as however ingeniously its fitting may be designed, the steam dome does necessarily and unavoidably weaken the barrel of the boiler. On the other hand, there have been deemed to be certain disadvantages attaching to the perforated pipe alternative. Thus, if the new and third alternative, namely, of dispensing with both, possessing as it does distinctly superior simplicity of method, proves to work with entire satisfaction in practice, another new departure, both valuable and interesting, will have been advantageously taken.

Water Troughs and Pick-up Scoops.

Water troughs are being laid down in the four-foot ways on the Great Western line near Starcross. This would seem to foreshadow some runs between Paddington and Plymouth without stop in the coming summer. The “new” Great Western—if I may use the expression—likes to keep well in front, and the long-vaunted “longest non-stopping run in the world”—viz., Paddington-Exeter, 193¾ miles—might at any time have its “nose put out of joint” by a rival. I am not now thinking of the London and North-Western's possibilities of London-Holyhead, 264 miles, or London-Carlisle, 299 miles. Those can be done, and have been, but it may be doubted whether they would be “practical politics” for daily use. The case of London-Plymouth is different. The relatively level road extends beyond Exeter to Newton Abbott, and it is only afterward that the severe grades come in; while the additional distance is not great. The London and North-Western, however, might at any time relegate the London-Exeter run to second place by running between Wigan and London without stop, instead of calling at Willesden, as at present. That would give a clear run of 194 miles, instead of 188½ to Willesden. At present the London and North-Western is a good second with 192½ miles. from Euston to Edge Hill, done by the American boat special. Euston-Wigan or Wigan-Euston would just turn the scale on that side. But Paddington-Plymouth, 245¾ miles, would clearly be an “easy first.” The more one realises the advantages conferred by the ability to pick up water at speed, the more one marvels at the slowness of its adoption.

When the London express is delivered by the London and North-Western at Carlisle and taken on by the Caledonian, fifty-five ton tenders succeed those of twenty-five tons previously used. These mean excessive haulage of dead weight, especially when two engines are used. Yet there are level stretches on the Caledonian where troughs could be laid, as there are also on the London and South-Western, which, like the Caledonian, still dispenses with this and drags about huge eight-wheeled tenders. It is somewhat curious that while such strenuous efforts are being made—and very properly—to augment the power exercisable per engine, the excess of dead weight needlessly hauled seems to be regarded with indifference. Yet obviously if the dead weight could be diminished by 10 per cent., the relative efficiency of each engine would *ipso facto* be proportionately augmented, and practically nine locomotives would do the work of ten. This, no doubt, is, like many other desirable things, “more easily said than done,” but when larger tenders add a further sixty tons of dead weight to a 400-ton train, and when four huge dining cars of an aggregate weight of more than 160 tons are hauled needlessly some seventy-three miles, over a summit of 1,080 ft. high, after their necessity has ceased to exist, one cannot help reflecting on the possibility of affording some relief in this direction to over-burdened locomotives—and *shareholders*.

Compounds and Compounds.

Extreme as has been the slowness with which the compound principle as applied to locomotives has come into use in Britain since its modern initiation by Mr. F. W. Webb in 1882, there at last are symptoms—if one may judge from appearances—that the principle is to receive a more extended trial henceforth than it has enjoyed hitherto. So far it must be admitted that the London and North-Western Railway and its late chief mechanical engineer have enjoyed an honourable, if regrettable, solitude as regards the compound crusade. Mr. Webb built his first compound locomotive just twenty-one years ago, completed at a cost not far short of £100,000, a first batch numbering thirty of the same type and class which, as express engines, have been unsuccessful—to put the case very mildly indeed—and then constructed four successive batches of forty, ten, ten and ten of express locomotives on the same principle but of different dimensions, all having three cylinders the first three of these batches proving distinctly efficient and useful. He also built a number of eight-coupled goods engines to his three-cylinder compound design. Then he suddenly and absolutely abandoned that design and brought out instead a four-cylinder system, differing in virtually every respect from its predecessor. It is now represented by eighty large express engines and a number of eight-coupled goods locomotives. That practically sums up the history of locomotive compounding on the only British railway that has systematically carried it out during a long term of years. The various sporadic experiments with different types of compound tank engines may be neglected as not germane to the real inwardness of the present subject. At the present moment there has been reached, through the retirement of Mr. Webb and the appointment of his successor, a break in the continuity of the compound chain. That is to say it is not yet known authoritatively outside the secret places of the Crewe offices whether the London and North-Western express locomotive at any rate of the future, is to be compound or non compound, and if the former whether of the four-cylinder or the three-cylinder type.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

The Report on the Bristol Fire.

Mr. Faraday Proctor's report on the causes of the Bristol fire has been presented and the conclusion come to is that it is traceable to one or other of the following causes :—

(1) By static discharge from the metal work of the board charged at high pressure, over the surface of the insulators and slate to "earth," or in other words, to the other pole of the board, in which case it is further possible that this may have been in a measure caused by an invisible crack in one of the insulators.

(2) By the breakdown of a joint-box wherein the cables from the machines or mains are connected to the switchboard.

(3) By the abnormal action of one of the machine fuses, the blowing of the fuse causing an arc and breaking the porcelain pot filled with oil in which the fuse is placed.

To the writer's mind the last is the most likely cause, and, at any rate, it is very certain that when once the fault commenced the spreading of the trouble was *mainly due to the oil*. A further trouble was, of course, the burning of the impregnated jute insulation on the cables connected up to the switchboard. It may be asked why was not the supply cut off from the Avonbank Station; this, it appears from the engineer's report, was due to the fact that all the private telephones were rendered useless by induction on the wires.

The Use of Oil for Electrical Apparatus.

The suppressing of arcing at switch and fuses contacts, etc., by immersing in an oil bath is all very well, but if there is any lesson to be learned from the Bristol fire it is that the employment of such an inflammable substance as oil on a switchboard is most unwise. As a matter of fact the old idea that the arcing on opening a circuit should be instantaneously suppressed is dying out. On the Continent most high-tension switches and many fuses are fitted with flaring horns similar to the Siemens and Halske lightening arrester, and the arc puts itself out by reason of the convection air-currents started by its own high temperature.

High-tension transformers are another piece of apparatus for which oil is often used; and if there should be an accident and the oil catch alight the results might be much worse than the mere burning out of one transformer. There is no doubt that when properly prepared oil is an excellent insulator, and that it tends to automatically heal up small faults, but this characteristic may be bought at too high a risk. Here, again, the writer is of opinion that oil is out of place, and that large transformers should be cooled by forcing dry air through the casing and between the coils and core, etc.

Importance of Not Suppressing an Arc too Suddenly.

To show the change which has taken place in engineers' opinions on the question of suppressing arcs the series parallel controller may be instanced. A few years ago anyone suggesting that these should be made without a magnetic blow-out would have been thought behind the times, and yet the tendency is now to *dispense with the blow-out*. Many of the cars at Glasgow, for example, have been running with ordinary type controllers for a considerable time. The bad effect of too suddenly suppressing an arc was well shown when the magnetic blow-out was first introduced into this country. It was found that English-built motors, which had worked well with ordinary controllers broke down badly when coupled to controllers having magnetic blow-outs. In order to withstand the additional stress, the insulation of the field coils had to be very considerably increased, the test pressure being over six times the working pressure.

Increase in Charges for Electricity at Cheltenham.

It is seldom that one hears of a town raising its price for electricity, and it comes, therefore, as somewhat of a surprise to find that Cheltenham finds the existing scale of charges unremunerative. Thus public lighting is to be increased from 1·91d. to 3d. and for private consumers from 5½d. to 6d. up to the equivalent of 500 hours' use per annum of the maximum demand recorded by the demand indicator; 2d. per unit being charged for all consumption during the year beyond this. The Light Railway Company is also to be notified of an increase, the present charge of 1·9d. per unit being unremunerative. There is undoubtedly much unrecorded history behind this statement, and it would be of great benefit to the community to have all the facts of the case made public. As things go throughout the country they are high, especially the 1·9d. per unit for traction.

Scientific Ladies.

Ladies are every day taking a greater part in scientific affairs, and there can be no doubt that for research work many have shown undoubted ability. Mrs. Ayrton's name will occur to everyone in connection with arc-lamp phenomena, and in radium research Madam Curie and Lady Huggins have done much towards probing this most interesting mystery.

As a rule the ladies keep to the purely scientific side, but it may be news to many that Mr. B. J. Lamène, the prolific inventor of the Westinghouse Company at Pittsburg, is most ably assisted by Miss Lamene. If all the writer has heard of this lady is true she can set about a complicated winding diagram or a series of calculations for a dynamo with the best of the Westinghouse staff.

POWER STATION NOTES.

BY E. K. S

The Smoke Nuisance.

One action of the municipal authorities with which practically everybody is in sympathy is the attempt which they are making to stop the reeking of smoke from chimney stacks. Electric stations have never, at their worst, been half so bad as factories, iron works, etc., but owing to the fact that electric stations must, of necessity, be built in cathedral cities, seaside towns and other show places, the matter assumes additional importance in connection with them.

Of course smokeless Welsh coal can be used, but the price is so high, compared with the various slacks which are available, that the temptation to use cheaper coal is great. Especially is this so as the coal item generally decides whether a power station will pay its way or make a loss. In large stations where mechanical stokers are employed the regularity of firing in small quantities reduces the tendency to smoky chimneys. It is in hand-fired boilers that the smoke preventer is most urgently wanted.

Smoke Preventers.

It may be interesting to briefly describe two methods of smoke preventers which have recently come before the writer's notice. The first, which has been fitted to the Babcock and Wilcox boilers in the Bath tramways station, is the invention of Mr. Appleyard, and merely consists of a small steam jet in each furnace, which the stoker turns on each time he opens the furnace door. There is, of course, a possibility of the stoker forgetting to do this, but it would be easy to attach a lever from the furnace door to the steam cock, so that it opened and closed automatically.

The other method is quite a novel departure, in that it involves the addition of a gas generator. It is being placed on the market by the Welskemp Smoke Consumer Syndicate and has already had a successful trial at Hornsey. The gas is produced from anthracite peas in a small water-sealed generator, a mixture of air and steam being forced through the incandescent fuel in the usual way. The gas is delivered into a pipe having 3 in. branches which pass underneath the fire-bars to a bridge at the back of the furnace. At this point a combustion-chamber or regenerator is built up of fire bricks, laid together without fire-clay and arranged in zigzag fashion. The furnace gases have thus to pass through a series of brick chambers heated by the gas flume from the 3 in. pipes, and there is no possible chance of black smoke issuing from the chimney.

The Underfeed Stoker.

The question of mechanical stoking follows naturally on the above subject of smoke prevention, for a good stoker is in itself a smoke preventer. Amongst the more recent types the underfeed stoker appears to promise very well. In this type a steam-driven ram pushes the coal forward at regulated intervals of one to three minutes into a trough-shaped fire-grate, and unlike most stokers the new coal *rises up from underneath.* Air enters the furnace from a series of tuyere blocks along each side of the trough, above the fresh coal but below the fire. It is therefore thoroughly mixed with the gases which are liberated in coking the fresh coal, and the result is practically smokeless combustion even with the cheapest slack. The non-combustible clinker falls on to dead plates which run down each side of the trough, and it is removed by hand at suitable intervals.

Steel-Plate Boiler Flues.

The new electric power station at Oldham is somewhat curiously arranged in that there are three rows of boilers, the outside rows being dry back marine and the centre row a new type of boiler, the Climax. The flues for the marine boilers are arranged underground in the usual way, but the flue for the Climax boilers runs along inside the apex of the boiler-house roof, about 40 feet above floor level. It consists of a steel tube 10 ft. in diameter.

In the States, steel flues are much used, thus the power house of the Lexington and Boston Electric Railway has the flue made of steel $\frac{3}{16}$ in. thick.

At the Central Electric Supply Co.'s works at Grove Road, Marylebone, 14 Climax boilers are in use, and the flue runs along the tops of the boilers and enters the chimney at the level of the boiler-house roof. The flue is constructed of double plates, with an air space of about three inches between them.

IRON AND STEEL NOTES.

BY E. H. B.

The Midland Wages Board.

Sir Benjamin Hingley, presiding at the annual meeting of the Midland Iron and Steel Wages' Board, said that, although trade had been dwindling throughout the year, ironworkers' wages continued unaltered. He saw no prospect of improvement, and no apparent lift in the clouds. They had all sorts of fiscal proposals, but he recommended industry, economy, and avoidance of waste.

Statistical Memorandum of the Tariff Commission.

From Mr. W. A. S. Hewins, Secretary to the Tariff Commission, I have received a memorandum and statistical tables respecting the iron and steel trades. These should be in the hands of all who are interested in British iron and steel. They are designed to focus attention on the industry as a whole, and not upon any part of it, however great. The inquiry has been divided into three main divisions :—

1. The analysis of official returns, British and foreign, bearing upon the conditions of industry here and in other countries.
2. The issue of forms of inquiry to the various trades in which questions are included to elicit information supplementary to that contained in returns already available.
3. The examination of representative witnesses from each leading trade with a view of testing the accuracy of the conclusions indicated by the two foregoing methods.

Inquiry forms thus far issued by the Commission have met with a generous response from manufacturers representing every shade of opinion on the fiscal question, and many thousands of replies have already come in. The first step upon receipt of these replies is to number the forms and provide for the absolute secrecy of the source of information where secrecy is desired. Only in a very small proportion of cases, however, do those replying to the inquiries wish their names withheld. It is announced that the examination of witnesses will shortly be commenced.

Styrian Steel.

An instructive lecture on Styrian steel was given by Mr. R. B. Hodgson at a recent meeting of the Birmingham Association of Mechanical Engineers. As far as Britain is concerned, the author showed that the primitive inhabitants of these islands were acquainted with iron, but the Romans taught the Briton how to treat and fashion the metal properly, and numerous ironworks sprang up in the Forest of Dean, Bath, Yorkshire, Cardiff, and other places. On the withdrawal of the Roman legions iron smelting languished for several years, and it was not until the sixteenth century that it revived. In 1581, so great was the consumption of timber for smelting that an Act was passed restricting its use within a radius of twenty miles of London, whilst in the twenty-seventh year of Elizabeth's reign an Act for the preservation of timber in Sussex, Surrey, and Kent was passed. Smelting iron by the aid of coal was not successfully accomplished until the early part of the seventh century, whilst coke was introduced one hundred years later. The lecturer then proceeded to trace the history of Styrian steel, showing the interesting link connecting the extensive works of Bohler Brothers at Styria with the remote past.

The Value of Microstructures.

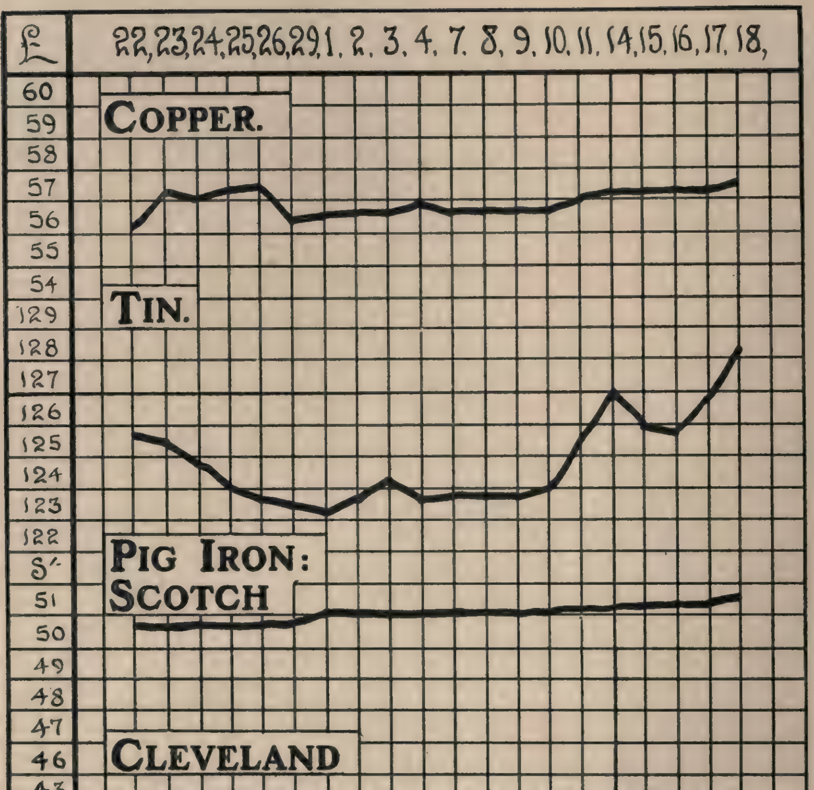
How far does a small section such as is used for microscopic examination, represent the structure of a mass of steel? We are so accustomed to microphotographs of steel in these days that one is apt to take them for granted. The question, however, is one of the first which is suggested to the engineer and metallographer and in a paper recently read before the West of Scotland Iron and Steel Institute, Messrs. A. Campion, F.I.C., F.C.S., and H. W. Watts, present a collection of notes which should be of assistance in clearing up this point. Mr. Walter Dixon stated the difficulty clearly in the course of discussion several years ago, when he raised the question in the following terms :—

"In considering such a subject, there always appeared to him one great difficulty. Perhaps it was an illusionary one, and if so, he should like to be rid of it. If the metals under consideration were perfectly homogeneous, *i.e.*, of exactly the same structure throughout, it is obvious that a section, however small, or however large, taken from any part of the mass, would under the microscope show identically the same structure; and the results so revealed by the microscope would be invaluable. Was it not, however, a fact that the metals so dealt with were, especially when microscopically considered, essentially of a heterogeneous nature, and that it might be impossible to take two sections from any one piece of metal which would show under the microscope identically the same structure? He stated that when he considered the subject he could never get out of his mind an example which might be taken from one of our coarser granites or marbles, which perhaps, in an exaggerated form, might represent the metals under discussion. From a cubic inch of many of these stones it would be possible to obtain hundreds of sections, not any two of which would be microscopically alike."

The author's investigations show very plainly that in the case of sections of steel of small mass and regular shape, the structure, as exhibited by the microscope, discloses but little variation at different parts of the piece, provided it has been subjected to the same treatment throughout. Round bars of large diameter of rolled material, and forged material for axles and spindles may exhibit considerable differences of structure between the outside and central portions. The differences, however, are (excepting in cases where the material has been specially treated) very little if any greater than those obtained in analytical and mechanical testing. Material in irregular shapes and unequal masses exhibit very considerable differences as regard both analyses and structures in the various portions of the section.

Such materials as axles and tubes of guns, which have been subjected to special treatment, as oil quenching and tempering, show the effects of the treatment in a marked degree on the outside portions. The carbide areas gradually diminishing in volume towards the centre where the structure (except in material of very small diameter) exhibits that of the material before treatment.

Although a large number of etching media have been suggested by various operators; and everyone has his own pet solution, they all give identical results when used under suitable conditions. The structure of some steels may be much more clearly developed by one method than another; but the ultimate result, as far as size of grain and constituents present, is the same in all cases.



THE HOME METAL MARKET.

Chart showing daily fluctuations between February 22nd and March 18th, 1904.

AUTOMOBILE NOTES.

In the course of a paper contributed to the Engineering Society of Glasgow University, Mr. J. E. Thorneycroft calculated that on the average, horse haulage cost 8d. a ton per mile, while the cost of motor haulage was 2¼d.

The Commission du Yachting Automobile has fixed the date of its motor boat race for 1904, which will take place on Monday, August 8th, about 10 o'clock in the morning, starting from either Calais or Boulogne and finishing at Dover.

Prominent at the interesting Automobile Exhibition at the Agricultural Hall was an ingenious six-ton tip wagon with telescopic lifting gear by the Lancashire Steam Motor Company, Ltd. Other vehicles for trade purposes were shown by Messrs. Foden, Ltd., of Sandbach; the Yorkshire Patent Steam Wagon Company, Messrs. J. Robertson and Son, of Fleetwood, the Hercules Motor Wagon Company, the Empire Hagen Motor Wagon Company, Messrs. J. and F. Howard, Mann's Patent Steam Cart and Wagon Company, Ltd., Wallis and Stevens, Ltd., and Savage Brothers, Ltd.

The first of the North-Eastern Railway motor coaches, after preliminary tests, went through a very satisfactory official test run of 60 miles on their main line. This coach was fitted with the first of the new "Wolseley" 80 b.h.p. petrol motors, constructed by the Wolseley Tool and Motor Car Company, Ltd., Birmingham. The petrol consumption was approximately one pint per b.h.p. hour. A speed of nearly 40 miles per hour was frequently attained, and the 60 miles test run was accomplished at about 30 miles per hour average speed, including four stops and starts. The coach climbed a bank 1 in 95 on each journey. Its weight is about 35 tons.

At the annual general meeting of the Automobile Club, held at the Institute of Mechanical Engineers, Westminster, Mr. Roger Wallace presided over a large gathering of members. Lord Shrewsbury moved: "That no member of the Automobile Club in the trade, or journalist connected with an automobile journal, be eligible for membership of the club committee." As an amendment Mr. Jarrott moved, "That as the club is primarily a society of encouragement, any attempt to secure that the trade section should not be represented would be unjust, unconstitutional, and fraught with danger." Mr. Jarrott's amendment was carried by a large majority.

The following entries have been received for the Side-slip Competition, which is to be held at the beginning of April, under the auspices of the Automobile Club: Mr. Mark Vivian (Chiswick), the Wilkinson Tyre and Tread Company (Huddersfield), The Continental Caoutchouc and Gutta Percha Company (London), Mr. Alexander Nicholson (Dublin) (2 cars), Commander Charles T. Scott (Sheffield), Rourke and Horsburgh (Bromley), Sainsbury's Anti-Skidders, Ltd. (London), Mr. Henry S. H. Cavendish (London), Mr. E. Midgely (London), Mr. Wm. Hunt (Kettering), Mr. Samuel Butler (Westbury-on-Trym), Mr. W. Maitland Edwards (London), Mr. Henri David (Paris), Grose, Ltd. (Northampton), Mr. John Harrington (Brighton), Parsons Non-Skid Company (London), Wm. Jenkinson and Co. (London).

As we go to press we are informed by the technical secretary of the Automobile Club that it has been decided that their Side-slip Competition shall commence by an endurance test of 1,000 miles, to be carried out in five or six days, starting from the Automobile Club at 9.30 on Monday, April 18th. On the completion of the 1,000 miles' run the cars will be submitted to the side-slipping tests, which will be carried out on the track round the new works of Messrs. Clement Talbot, near Ladbrooke Grove. The track is wood pavement, which will be made greasy, and the cars will have to make a right-angle turn on the grease, to describe "S" curves, and also to be subjected to brake tests. The power absorbed by the device will be tested by running the car down-hill by gravity both with and without the device fitted, and measuring the distance between the stopping places in each case.

Points will be given for ease of attachment and renewal and for price, and a device which gives the best control of the car under all possible conditions, that is to say, whether for side-slipping of front or back wheels, or of forward skidding, will be considered the better.

Eighteen cars will actually take part, and each of these will carry an honorary observer throughout the whole of the 1,000 miles to see that nothing is done to the device. We note that a number of observers are still required.

Discussing points about the 1904 motor bicycle, in which there is room for improvement, Mr. B. H. Davies, in the "Motor Cycle," recently remarked:—

"Bowden wires, in my experience, are either badly fitted by the majority of workmen, or are not made of sufficient strength; the makers say the former, of course, but I should be better pleased if the strands had a margin of strength to allow for unskilled fitting. Most of the modern silencers belie their name; the rider does not notice the noise, but other road users do. Carburetters should be made dustproof. Oil tanks and connections are often carelessly finished; every new machine I have had has leaked oil fiercely, and in each case the cure has been simple, showing the fault to be unnecessary. Two accumulators are a great advantage. The rear horseshoe brakes are inaccessible on one or two machines, and are not substantial on any. On two occasions mine has fouled the valve and ripped out spokes, on one occasion buckling the wheel so that further progress was impossible. Handle-bar control of *all* the operations is not necessary. I prefer to have a switch and exhaust lifter on the handle-bar, and long levers on sectors screwed on the top tube, for throttle, air, and spark. Stronger free-wheels and protectors for them are a crying need. Every clutch I have owned has gone sooner or later. Increased petrol capacity ends my list of desiderata, as the chief of all is a practical impossibility, *i.e.*, detachability of the engine." In spite of all this, Mr. Davies strongly emphasises the fact that the 1904 motor bicycle may be relied upon to "get there."

AMERICAN RÉSUMÉ.

By Our New York Correspondent.

NEW YORK, March 19th, 1904.

The Man and the Lamp.

The annual dinner of the American Institute of Electrical Engineers was an event of more than ordinary importance by reason of the tribute paid to the genius of Thomas Alva Edison, whose fifty-seventh birthday synchronised with the event. The organisers with a fertility of enterprise worthy of the occasion, also arranged that the dinner should represent the twenty-fifth anniversary of the practical perfection and commercial introduction of the incandescent lamp, while at the same time the Edison Medal, founded for research in theoretical or applied electricity or magnetism, was also inaugurated.

Congratulations poured in from all parts of the world, including a tribute from the President of the British Institution of Electrical Engineers. From President Roosevelt came the message: "I congratulate you as one of the Americans to whom America owes much; as one of the men whose life work has tended to give America no small portion of its present position in the international world." Mr. Carnegie did not hestitate to subscribe himself as Liegeman to King Edison I. The post prandial proceedings were of the happiest character,

Mr. T. C. Martin gave Mr. Edison's health in the following terms :—

"The American Institute of Electrical Engineers is proud to embrace in its membership to-day the foremost inventors of the age and the greatest captains of industry, and has placed upon its golden tablets many an auspicious discovery and art to celebrate. But it surely could find no worthier hero among them and no better gift to mankind to signalise than the man and the lamp around both of whom we twine to-night the laurel wreaths of our admiration and our love.

"There should be encouragement in the founding of this medal to-night for every struggling, ambitious youth in America. Let us and let our sons recall and applaud the cheery little newsboy at Detroit, the half-shod, half-frozen operator seeking bravely a job along the icy spikes of the Central States; the gaunt, untutored experimenter in Boston, taking eagerly needed fees for lectures he was too modest to deliver; the embryonic inventor in New York, grubstaked by a famous Wall Street man for his first stock ticker; the deaf investigator at Menlo Park, who wreaked unique retaliation on his affliction by preserving human speech for ever with his phonograph; the prolific patentee who kept the pathway to the Patent Office hot with his footsteps for nearly forty years; the genius, our comrade, who took this little crystal bulb in his Promethean hand and with it helped to give to the world a glorious new light which never was before on land or sea—Thomas Alva Edison."

Edison's Reply.

Edison's telegraphed his speech to the assembled guests as follows :—

I want to thank first of all my fellow-members of the American Institute of Electrical Engineers for the great honour done me in thus celebrating my birthday, associated with the twenty-fifth anniversary of the completed development and successful introduction of the incandescent lamp. Your expressions of good-will gratify me deeply. While I cannot but rejoice at the place which the incandescent lighting art has made for itself among the inestimable comforts and conveniences of civilisation, I feel that my share in the work is exaggerated by this prominence given me to-night.

To my old friends and associates who have founded the Edison Medal in the Institute—I can but extend you thanks again. If I could do it in return, I would found a medal for every one of you, for you are just as much entitled to recognition as I am. You gave me your friendship and loyalty, your watchful days of toil and sleepless nights of anxiety. Some of you helped to perfect the art by your engineering skill, your legal ability, your financial aid.

The early days were enough to tire out any one's courage and persistence, but you stood it all, and put up with me into the bargain. Now, in noble revenge for the burdens I put on you, and in addition to all the evidences of friendship in the past, you add this unusual token of continued affection. I should not be human if I were not profoundly affected and deeply grateful.

This medal is founded to encourage young men to devote their best thought and work to electrical development. I rejoice in this stimulus to harder study. Better trained and educated than were we men pioneers of the times before every college and university had its electrical course, these coming men of the future should, and I believe will, carry forward to triumphs and arts heretofore undreamed of, the principles and applications of electricity to which I have tried humbly to devote my life and energies from the hour my hand first touched the key. God bless them, and you, my dear friends, and this American Institute of Electrical Engineers.

The Westinghouse Single-phase System on the Indianapolis and Connersville (U.S.A.) Railway.

The Westinghouse Electric and Manufacturing Company, of Pittsburg, have undertaken the equipment of two long inter-urban railways in the United States on their new single-phase system. One of these is the Fort Wayne, Decatur and Springfield road, which extends from Fort Wayne (Ind.) to Springfield (Ohio), a distance of about 110 miles; the other a high-speed line 53 miles long is to run from Indianapolis to Connersville (Ind.), but will eventually be extended to Hamilton, a total distance of 93 miles.

As showing the adaptability for single-phase working of present types of generating plant, it may be mentioned that it was first decided to work the Indianapolis and Connersville line on the direct-current system; but the single-phase system was adopted on account of its lower first cost and running expenses. Although two 500-kilowatt high-voltage three phase generators had been placed on order for the direct-current working of the line through rotary converters, it was not found necessary to do away with these, the power station equipment, so far as the engines and generators are concerned, remaining as first laid out. The generators will develop a pressure of 2,300 volts, and this pressure will be stepped-up to 16,500 volts two-phase for transmission on the Scott system to the six static transforming sub-stations, which will be located every ten miles or so along the line. Half of these stations will be connected on one phase and half on the other, and the supply will be reduced to a trolley voltage of 3,300, transformers on the cars bringing this pressure down to the working level. The trolley wire will be No. 000 B and S gauge copper. Induction control (*i.e.*, by means of a rotatable core transformer) will be adopted on the Fort Wayne and Springfield road; and rheostatic control on the Indianapolis-Connersville line, the car equipments of the latter having to be worked with direct-current within the confines of Indianapolis City. The first ten cars ordered will be each equipped with four 75-h.p. motors, so geared as to develop a speed of 42 miles per hour on the level. The consulting engineers estimate that the adoption of the single-phase in place of the direct-current system will result in a saving of £100,000 on the whole line from Indianapolis through Connersville to Hamilton.

These two lines will be the first in the world to be equipped upon the single-phase system, and their completion and working will doubtless be looked forward to with great interest by English railway engineers.

The Late Senator Hanna.

The late Senator Marcus A. Hanna, although chiefly known to fame as a politician, did not enter the political arena until he had attained ripe experience as a business man. From 1857 to 1867 he was connected with the oil trade, but in the latter year he transferred his attention to iron and coal, becoming senior partner of the firm of Rhodes and Co., who were heavy dealers in coal and iron, their coal mines being in Tuscarawas county. This firm, dissolved in 1885, was succeeded by that of M. A. Hanna and Co., which consisted of M. A. Hanna, L. C. Hanna and A. C. Saunders. Senator Hanna proved himself a born organiser, and in the negotiation of innumerable business propositions proved himself a capable leader of men. One of his most notable characteristics was his successful method of settling controversies with his employees. He took a pride in saying that he never had any serious labour trouble. A business associate who was asked for his ideas as to the secret of Mr. Hanna's success in business, said: "First, I would place his rare good judgment. He seldom erred. He also had great ability in looking into the future and foreseeing the course of events. His capacity for work seemed to be unlimited and his energy was untiring. Another characteristic, which contributed to his success, was his faith in men whom he believed to be honest. When once convinced that a man was honest, there was nothing in his power that Marcus A. Hanna would not do for him. More men than the public has any idea of were helped along in the battle of life by Mr. Hanna. Sometimes when a man had made grievous mistakes and had been rejected and even branded as dishonest by former associates, Mr. Hanna, if his confidence remained unshaken, would still freely extend a helping hand. In all of his long business career there was never the slightest hint that he was guilty of anything inconsistent with the highest integrity. One cannot say that he ever was tempted to do anything dishonest. He simply would not consider anything of the kind. His policy was always one of frankness and honour. Although he had many friends among men high in the political world, he will be mourned by none more deeply than by the wage earners on docks and vessels, in mines and at furnaces, who, by coming in contact with him, grew to love him."

Baldwin Locomotive Works.

Some time ago, in PAGE'S MAGAZINE, a series of articles by Mr. Joseph Horner on the Laying-Out of Workshops, called attention to the difficulties of engineers in providing for the necessary expansion of their works. Improvements have recently been made at the Baldwin Locomotive Works which show that limitations of space surface need not be an insuperable bar to expansion. The first thing to be done was to remove all heavy hammers to the Standard Steel Works at Burnham, Pa. All heavy castings are also made at the same place, besides most of them for light work. This change of location of heavy work relieves the pressure and allows the erection of a boiler shop on the second storey over the old foundry, and the erection of a blacksmith's shop for light work, besides a frame drilling and fitting-up shop on second floor over the old blacksmith's shop, and the work of fitting up throttle valves, stand pipes, dry pipes and piston valves on the second floor over the old cylinder shop. These examples of an effort to be freed of entanglements due to lack of ground area, have worked out most satisfactorily, and are giving results looked for in an increased output. Another large factor to this end was the installation of the plant at 26th Street, to be used exclusively in the final application of fittings, an engine and tender, prior to shipping from the works.

The Panama Canal.

The American Chamber of Commerce Bulletin remarks that with only fourteen votes in opposition, the United States Senate on February 23rd ratified the Panama Canal treaty, and early construction operations are now assured. Many important American commercial interests have already laid their plans for reaping practical advantage from the new waterway. The New Orleans Board of Trade, the chief business body of the Southern metropolis of the United States, has given its indorsement to a project to build a line of steamships to pass through the canal and trade with the Western countries of South America and with Asia. The plan is to build a fleet of large, swift, modern vessels, to interest the entire Mississippi Valley in the project, to raise $5,000,000 for the work, and to get the Governors of the States in the valley, the mayors of the cities and all its commercial bodies to take a hand in the scheme by way of subscribing for the stock or receiving subscriptions.

Allis-Chalmers Developments.

It is announced that the Allis-Chalmers Company is about to engage in new lines of manufacture, namely, steam turbines, hydraulic machinery, gas engines and electrical machinery.

SOUTH AFRICAN RÉSUMÉ.

By Our Johannesburg Correspondent.

JOHANNESBURG, March 11th, 1904.

Rhodesian Mineral Output.

The following are the official figures for the year 1903, published in the report of the Rhodesia Chamber of Mines :—

	Gold.		*Silver.*	*Lead.*
	Ozs.	*Dwts.*	*Ozs.*	*Tons.*
January	16,244	11·29	—	—
February ..	17,089	13·83	—	—
March	19,626	5·95	—	—
April	20,728	1·31	—	—
May	22,137	9·11	—	—
June	22,166	8·35	—	—
July	23,570	15·21	—	—
August	19,186	14·31	—	—
September ..	18,740	13·27	4,160	19·50
October	17,917	13·87	4,281	27·30
November ..	15,713	16·25	4,757	49·56
December ..	18,750	2·21	2,573	31·60
	231,872	4·96	15,771	127·96

The next table shows the progress that has been in the output of gold :—

	Ozs.	*Dwts.*
Output prior to December 31st, 1898	24,555	13
Output for year 1899	65,303	13
Output for year 1900	91,940	8
Output for year 1901	172,061	8·75
Output for year 1902	194,169	6·23

A Geological Discussion.

During the present dull season, the mining experts are finding occupation for themselves in discussing the origin and nature of some of the strata of the main reef series, and more particularly with that layer of rock which has been known as the "Hospital Hill shales," because it was considered by everyone to be of sedimentary origin.

Mr. G. A. Denny, consulting engineer to Messrs. Albu, has, however, recently declared this rock to be of igneous origin, and he submits, as evidence of his contention, a number of hand samples, and also microscope sections and chemical analyses. But Dr. Hatch and Mr. Dorffel, who uphold the accepted view as to the origin of these rocks, not only disagree with Mr. Denny's conclusions, but challenge his evidence in detail.

The opposing statements given in parallel columns below will show how very fundamentally even experts may differ, and they also suggest the desirability of referring the disputed sections and samples to some school of mines or other authority whose views are not influenced by any local considerations or previous correlations of reefs.

Petrological Divergencies.

Mr. Denny's microscopical determinations.	Dr. Hatch's determinations of same slides.
Nos. 73 and 80. Dolerite.	Distinct quartzitic slate.
No. 76. Dolerite.	Quartzitic slate is full of quartz fragments.
No. 155. Footwall dyke.	Quartzitic slate full of quartz fragments.
No. 169. Granular dolerite.	Beautiful example of fine grained quartzite.
No. 170a. Porphyritic dolerite with zonal structure induced by weathering.	Quartzitic slate, with banded structure due to variations in size of quartz fragments.
Nos. 219, 220, and 221. Porphyritic dolerite with felspar and olivine.	Quartzitic slate with fragments of quartz and much dusty interstitial matter.
No. 222. Holocrystalline dolerite.	Quartzitic slate with fragments of quartz, etc.
Nos. 244, 245, and 273. Holocrystalline dolerite.	Quartzitic slate with many quartz grains in dusty matter.

Differences of Opinion.

Mr. Denny says :—	Dr. Hatch says :—
"This rock" (from the Bird Reef) "is pronounced by Messrs. Hatch and Molengraaf to be slate and the Hospital Hill 'shales' are also stated to be slates, but the microscope, supported by the field evidence, abundantly and conclusively proves that the rock" (the rock from the Bird reef is here referred to) "is eminently crystalline and of eruptive origin. If, therefore, individuals of acknowledged authority on geological subjects can, by adopting locally accepted theories, so confuse the fundamental classification of rocks as to detect no difference in a slate and an intrusive rock, it cannot be expected that unscientific observers will be able to discriminate between them, and if this rock has been called a slate merely because it has a somewhat shaly structure, it can be understood how it is that the structure of the Hospital 'shales' has been universally accepted as an incontestable proof of their sedimentary origin.	"After this examination of Mr. Denny's sections I have not the slightest hesitation in stating my opinion that Mr. Denny's igneous theory of the Hospital Hill shales is founded on an incorrect determination. I am convinced that the true character of these shales will be recognised at once by all petrologists who will take the trouble to examine thin sections of them under the microscope."

Chemical Divergencies.

Mr. Denny says :—	Mr. Dorffel says :—
1. The percentage of silica is far below the average of a typical slate or shale, and is in cases less than half that required as an essential constituent in fine-grained quartzite.	1. The percentage of silica is not below the average of a typical slate.

2. That practically no quartz is to be seen in the ground mass.	2. The ground mass consists largely of quartz.
3. The percentage of basic oxide is excessive, and unlike any slate or shale, and quite impossible in a fine grained quartzite.	3. The percentage of iron oxides is not excessive, but is characteristic of this type of ferrugenous slates.
4. That the rocks differ essentially from typical slates or shales or fine-grained quartzites in microscopic features since no granular structure can be recognised.	4. This rock closely resembles other well-known slates, and the structure is in many cases distinctly granular.
5. That crystals of felspar, augite, olivine, etc., can be recognised, but not always individualised in the less decomposed specimens.	5. Fragments of felspar and augites may be present without proving igneous character, but I have not seen any. Olivine in no case is, and cannot be present.
6. That they are truly eruptive rocks.	6. It is difficult to see how rocks with the abovementioned characteristics can by any stretch of the imagination be described as eruptive rocks.

The Outlook at Johannesburg.

The depression continues unabated. Even the building trade is now suffering, as the reduction of population has been proceeding at the same time that houses have been built in all directions round the town by those who, during the squeeze of twelve months ago, could not find accommodation. Although rents have come down a little, they are yet high, and it would still pay to build houses rather than to rent them, but owing to scarcity of money and the uncertainty of the next few months, few people have the money, and fewer still the courage to invest in residential buildings.

To one who lived through the Johannesburg slump of 1889–90, and experienced the rapid recovery which took place, there is nothing permanently disheartening in the present state of things, but it is not surprising that many newcomers have not been able to hold out, and have returned to their "place of origin."

And although certain of the ultimate triumph of the mining industry over its many difficulties, of which the chief one, of course, is the scarcity of labour, it is impossible to guess how long the present conditions may last. In the meantime this is a place to be avoided by all but confirmed optimists of independent means.

COMING EVENTS—APRIL.

2nd.—Birmingham Association of Mechanical Engineers: Paper on "Gas Measurement." Staffordshire Iron and Steel Institute, the Institute, Dudley, at 7 p.m.

7th.—Civil and Mechanical Engineers Society, Caxton Hall at 8 p.m. Liverpool Engineering Society, Royal Institution.

9th. — The Manchester Association of Engineers. Birmingham Association of Mechanical Engineers: Visit to the Oldbury Gas Works. North of England Institute of Mining and Mechanical Engineers, Newcastle-on-Tyne, at 2 p.m.

11th.—Society of Engineers, the Royal United Service Institution, at 7.30 p.m. The Institute of Marine Engineers, Stratford, E.

12th.—Institute of Civil Engineers, at 8 p.m.

14th.—Institution of Electrical Engineers, at 8 p.m. Leeds Association of Engineers: Annual Meeting and Election of Officers. Mining Institute of Scotland: Annual Meeting at Hamilton.

15th.—Institution of Mechanical Engineers, at 8 p.m. City of London College Science Society, London College, at 8 p.m.

16th.—North-East Coast Institution of Engineers and Shipbuilders: Graduates meet at Middlesbrough. Midland Counties Institution of Engineers, the Midland Institute, Leeds.

19th.—Institution of Civil Engineers, at 8 p.m. Institution of Engineers and Shipbuilders in Scotland.

20th.—Birmingham Local Section Institution of Electrical Engineers, at the University.

21st.—Institution of Mining and Metallurgy, at 8 p.m. Birmingham University Engineering Society meet.

22nd.—North-East Coast Institution of Engineers and Shipbuilders meet. Institution of Civil Engineers: Students meet at 8 p.m.

25th.—Society of Arts: Cantor Lecture.

26th.—Institution of Civil Engineers, at 8 p.m.

28th.—Institution of Electrical Engineers meets. Liverpool Engineering Society: Annual Meeting at the Royal Institute. Leeds Association of Engineers, meet at 7.30 p.m.

30th.—Staffordshire Iron and Steel Institute: Annual Meeting.

GERMAN RÉSUMÉ.

BY

DR. ALFRED GRADENWITZ.

BERLIN, March 22nd, 1904.

The Use of Steam Power in Prussia.

The increase in the use of steam power in Prussia since April 1st, 1902, is shown by the following table, for which we are indebted to the "Zeitschrift des Vereins Deutscher Ingenieure." This table does not include locomotives, boilers or engines used for the Army and Navy. The Marine boilers and Marine engines recorded are exclusively used for propelling ships, while these also include 698 steam boilers, with 1,962 steam engines for the operation of steam dredgers, cranes, etc. The latter are, according to their design, recorded together with stationary or transportable steam boilers and engines :—

	1902.	1903.	Absolute increase.	Increase Per cent.
Stationary steam boilers	72,098	73,181	1,083	1·50
Stationary steam engines	77,583	79,257	1,674	2·16
Transportable steam boilers	22,259	23,211	952	4·28
Steam engines connected thereto ..	21,612	22,556	944	4·37
Inland steamships ..	1,757	1,814	157	8·92
Steam boilers thereon	1,984	2,047	63	3·16
Steam engines thereon	1,946	2,018	72	3·70
Sea steamships ..	502	535	33	6·57
Steam boilers thereon	675	722	47	6·95
Steam engines thereon	533	571	38	7·15
Marine boilers, total	2,659	2,769	110	4·14
Marine engines, total	2,479	2,589	110	4·44

High-Speed Locomotives.

M. Buhle, in a paper recently published in Dingler's 'Polytechn. Journal" (Vol. 319, No. 8), describes a high-speed locomotive designed by Messrs. Henschel und Sohn, Cassel, for commercial speeds of about 130 kilometres. This locomotive is being tested on the Marienfelde-Zossen military railway in connection with the steam-locomotive high-speed trials organised by the Prussian railway department as an indirect consequence of the famous electric traction trials. This engine has two trucks and two driving axles, a heating surface of about 260 square metres and about 4 square metres of grate surface, corresponding almost entirely with the conditions enunciated in 1902 in connection with the High Speed Railway Competition of the Verein Deutscher Maschineningenieure.

Another type of locomotive described by the author is the hot-steam locomotive designed by Dr. H. Mehlis, to whom one of the prizes in the above competition was awarded. The engine is a 2-6 coupled tender-engine with a front and a rear truck ; this type was chosen on account of the fact that tenders of the usual design, even in the case of the water capacity being as high as 20 cubic metres, have too small a distance of the wheel centres for warranting a steady run with speeds ranging between 120 and 150 kilometres per hour. The distance of the wheel centres is 12·4 metres, and the boiler axle is, in accordance with American practice, placed at a distance of 2·55 metres above the upper edge of the rail. The locomotive has four cylinders with four cranks, acting on the rigid front axles. The weight of the engine, at no load, is about 58 tons, whereas the working weight is estimated at about 76 tons. Of the heating surface in contact with the water, measuring 146 square metres, about 126 square metres are intended for conveying the train, while 20 square metres are reserved for the electric lighting, generated by a 15 h.p. Laval steam turbine, the operation of ventilators, braking, heating, etc. ; in addition 34 square metres of superheat heating surface are provided.

Precautions for increasing the Safety on the Berlin Underground Railway.

Shortly after the Paris disaster a commission was appointed for causing such precautions to be taken as would be likely to increase the safety on the Berlin underground railway. These have now, for the greater part, been carried out. The lighting of the tunnel has received an additional independent wire, which, in the case of one half of the lamps being injured, will enable the remainder to go on burning. The conductor's stands on the underground railway stations are so designed as to be readily pushed aside. The number of fire hydrants has been increased, and each car has been fitted with a sand box. There are bucket fire engines in each car, as well as in the tunnel at distances apart of 100 metres. Each station has been connected to the fire-brigade alarm line. The emergency lamps in the cars are prevented from any contact with the curtains, the latter being, moreover, of a heavy impregnated wool stuff. Each motor-man's stand is provided with short-circuiting devices which may be operated even from within the car, serving to cut the current out of the line.

Telegraphing Pictures and Handwriting.

In an address recently delivered at the Berlin Urania, Professor Cerebotani presented a telegraphic apparatus for transmitting any kind of handwriting, drawing, etc. The fundamental principle is identical with the principle employed for instance by Elisha Gray, the novel feature being a singular highly sensitive system of electromagnets. In older schemes, in which the drawing pencil of the transmitter was moved upwards in an oblique direction, the line obtained in the receiving apparatus was a broken one. In the Cerebotani system the electromagnets are so sensitive as to produce nearly straight lines even in the case of their being excited by extremely feeble currents.

The telegraphic transmission of pictures and handwriting, as obtained by means of his apparatus, is therefore much clearer and truer than with any previous apparatus. Some samples produced by Cerebotani were transmitted on the telegraph lines from Munich to Augsburg, from Milan to Turin, and finally from Berlin to Munich. A picture transmitted some days ago from Berlin to Munich over a distance of 650 kilometres is said to be the finest specimen ever telegraphed.

The Berlin-Hamburg High-Speed Railway.

Both of the two schemes for an electric high-speed railway between Berlin and Hamburg, which have lately been presented to the Prussian railway department, provide an electric central station to be installed in Wittenberge, being the main station between Berlin and Hamburg. It is anticipated that the journey between the two cities, which at present requires upwards of three hours with the fastest rapid trains, will eventually be made in one and a-half hours only. As a matter of course, a new road-bed will be necessary, but the cost of this reconstruction does not seem to be prohibitory. The fact that a third track has been found necessary (which in the case of the electric high-speed railway being installed could evidently be dispensed with) is illustrative of the dense traffic obtaining between the two largest German cities.

The Use of Wind-Motors for Generating Electricity.

At a recent meeting of the Leipzig Electrical Society, Mr. R. Brauns delivered an address upon modern steel wind-turbines and their use for generating electricity. Similar wind-motors, with devices for automatic adaptation to the direction and strength of the wind, have been built in America by Halladay; the principal drawback connected with it being the large number of levers and rotating points required. The "Ultra-Standard" motor on the other hand, while showing the same defect, allows of higher efficiency as the working surface is not too great as compared with the inlet opening for the wind.

The Herkules wind-turbine, built by the Deutsche Windturbinen Werke, Dresden, shares many features with American wind-motors, where the whole of the wheel is gradually withdrawn from the action of the wind as for increasing intensities of the latter a higher pressure is produced on one side of the wheel, which is sufficient to overcome the tension of the springs supporting the wheels at right angles to the main vane, the surface exposed to the action of the wind being diminished by its being placed in a position parallel to the direction of the wind. The Herkules motor, however, is capable of being built up to the highest sizes, the regulations with respect to the intensity of the wind being made so accurate by a lateral regulating vane as to warrant an absolute safety against storm and a uniform number of revolutions. This regulation of the wind-turbine is sufficient to ensure a uniform operation of the dynamo. There is an automatical switch inserting the dynamo in connection with its accumulator battery as soon as the number of revolutions has reached suitable figures, and disconnecting it as soon as the strength of the wind is no more sufficient; the whole of the operation being automatical, no supervision is necessary. As, on the other hand, the vanes of the turbine are paddle-shaped, showing helicoidal contortions, the output is said to be 30 per cent. upwards of that of existing wind-motors. The battery may even be charged with a wind only four miles per second in speed.

These motors have for some time past been used for driving even large-sized threshing machines and other agricultural as well as wood-working machines.

Producer Gas-Plant for Brown-Coal Briquette Operation.

An electricity works, comprising a 100-h.p. producer as dynamo, which was recently installed in Hoyerswerda, Germany, appears to be the first central station where the producer gas-plant is operated by means of brown-coal briquettes. The gas-motor is quite identical with those used in connection with lighting and anthracite generator-gas, the producer gas-plant being also quite analogous to the usual design, being made up of the generator proper, the dust collectors, the scrubber, and the sawdust cleaner. After this means of operation had been adopted in October last, it has been carried on continuously with most successful results and without any disturbances, working about fourteen hours daily; no reserve was so far provided. Now another similar gas motor of the same output is at present being installed. Tests made some time ago showed the piston to be free from impurities from tar or paraffin. The brown-coal briquettes used were composed as follows:—

Carbon	48·32	per cent.
Hydrogen	3·35	..
Oxygen and nitrogen	26·54	..
Sulphur	1·09	..
Ashes	5·00	..
Moisture	15·70	..
Total	100·00	..

The heating value is 4,853 heat units.

A rough experiment, intended for ascertaining the consumption of fuel which was made during ten hours (the briquettes being unloaded from weighed buckets and the output being read on the ampere and voltmeter) gave the value of 0·65 kilogrammes per h.p. hour.

Operating generators with brown-coal briquettes proves in many respects more convenient than anthracite operation, the generator being never obstructed by slags. After the normal pauses in operation, it may be started again without any blowing-in; the door leading to the ashpit may be opened during the operation so as to clean the grate, which on account of the absence of any slag is rather easy and simple.

As Germany is mainly compelled to derive her supply of anthracite from abroad, the use of brown coal is likely there to afford a convenient fuel at a lower cost; the use of brown-coal briquettes seems to be especially suitable to small concerns in the centre of cities, on account of the possibility of having a supply of brown coal even in small quantities, as well as of the cleanliness and commodity of its storing up. This will no doubt serve to further the development of producer gas-plants.

MINING NOTES.

By A. L.

The Coal Tax.

At a National Conference of coal miners of Great Britain, representing seven hundred thousand workmen, held at the Westminster Palace Hotel, the chairman (Mr. Enoch Edwards) said they ought again to ask the Chancellor of the Exchequer to remove the iniquitous tax upon all exported coal. It was said that the tax would fall upon the foreigner, and that it would not affect the coalowner or the miner. But he wanted to know how the Chancellor of the Exchequer could explain how it was that before the coal tax was imposed France only took 5,000 tons of coal from Germany, but last year she received no fewer than 863,000 tons, the whole of which used to come from this country. The situation had changed since this coal tax was imposed, when there was a boom in trade, but now that it was depressed the tax was being severely felt. A letter was read from Mr. Austen Chamberlain, who said that until the Royal Commission on Coal Supplies of this country had completed its inquiries and issued its report, he felt precluded from making any addition to the statements made by his predecessors on the subject, and therefore he felt that no useful purpose would be served by his receiving a deputation such as they proposed at the present time. After a lengthy discussion it was resolved unanimously: "That we continue to protest against the tax on exported coal until the tax is repealed, and that we protest against the action of the Chancellor of the Exchequer in refusing to meet a deputation representing the miners of the United Kingdom." It was urged, and very generally accepted, that there should be a federation of the whole of the coal trade organisations, and if necessary to secure a living wage, the whole of the miners should cease working. The question of the Trades' Disputes Bill was also discussed, and it was resolved to support the Bill.

Spontaneous Combustion in Mines.

The question of fires in mines, with more particular reference to coals in the North Staffordshire coalfield, was discussed at a meeting of the North Staffordshire Institute of Mining and Mechanical Engineers. Mr. G. E. Lawton, the author of the paper, remarked that the principal causes of fires in mines were spontaneous combustion of the coal or of the material in the goaf, accidental ignitions of timber by open lights, explosions of fire-damp, underground boilers, furnaces, steam pipes, electrical appliances and shot firing. The most common cause of pit fires was spontaneous combustion. Perhaps there was no coalfield which contained more seams of coal subject to take fire spontaneously than the North Staffordshire coalfield. Fires had occurred in the Great Row, Cannel Row and Rowhurst coals in the Hanley district, and in the Yard Seam in the Longton and Fenton districts. Incipient fires in the Ten Feet Seam had been experienced in the Burslem district. The Seven Feet Banbury took fire in the north-western part of the coalfield, and the Eight Feet Banbury, or Cockshead coal, had taken fire in the Longton and Talke districts. The Bullhurst Seam, which was notorious for the frequency of fires, appeared to be liable to take fire, more or less, over the greater portion of the coalfield. Small coal constituted one of the most important factors in the origin of spontaneous combustion, but many other agencies assisted in bringing it about. One theory was that combustion was brought about by physico-chemical actions and reactions of gases, liquids and solids. other agencies which appeared to propagate combustion were oxidation of coal or surrounding material; also rock pressure.

Gob-fires of the worst type had been produced where slack had been left behind in the goaf, and these fires were greatly facilitated by allowing slight currents of air to pass through the goaf.

That Bete Noir.

At the annual meeting of the Association of Mine Managers of the Transvaal, the chairman, Mr. R. M. Catlin, remarked he would not burden the patience of the meeting by an extended reference to that "bête noir" of all their meetings, "the native labour question," but years of habit would preclude the omission of the phrase in any assembly in that place whose walls must be surcharged with the sound. Mechanical ingenuity had done, and was doing, much to cheapen the cost of production, but there was a limit beyond which these improvements could not go—there must always be use for the "hewers of wood and drawers of water." The presence there of a quantity of cheap labour had probably had quite as much to do with the building up of the industry as the presence of the gold in the reef. In fact, it was probably the more important factor of the two, for the gold contents was an immutable fixed fact which no social or political upheavals or other act of man could alter, while the cost of production was helplessly dependent on the other factor, which could be made the shuttlecock of party politics. But the fact remains that if those fields were to be fully worked there must be a sufficient supply of unskilled labour, and as it was clearly the one condition on which all other South African problems depended, it seemed fair to assume that sooner or later the solution of that problem would be found.

Among the advantages enjoyed by the industry, not the least was the happy arrangement of the mining laws, which seemed to minimise litigation. Few new mining regions had so signally escaped the blight of litigation. The report of the council dealt very fully with the various matters that have come before the Association during the year. A new set of mining regulations had been provided by the Government, and it was evidently the earnest desire to make them as perfect as possible, and to consider such improvements in them as practical experience might suggest. They were framed with great care by the Government, after consultation with the various interests involved, and, while time and experience might suggest some alterations, as a whole they reflect great credit on the care and patience of the official who prepared them.

In the course of further remarks the chairman said the coming year gave promise of better times. Much of the legislation necessary for the proper conducting of the industry had already become law; the country was fast settling down to the new conditions, and it was to be hoped that before the year closed the industry would be in a fair way to even greater prosperity than it had ever enjoyed.

A New Electric Mining Plant.

For the Gwendreath Valleys Anthracite Company the British Westinghouse Company are supplying and erecting a generating plant with all accessories and numerous motors. The plant will be on the three-phase system and will have a capacity of 200 kilowatts; the motors will be all of the Westinghouse polyphase induction type. They will be utilised to drive pumps, a 100 h.p. main and tail haulage and Waddle fan with a capacity of 50,000 cubic feet per minute, etc.

OPENINGS FOR TRADE ABROAD.

Belgium.

Tenders for the construction of shipbuilding yards, stocks, etc., will be opened on July 28th next, in the Bureaux du Service Spécial de la Côte, at Ostend.

On April 6th tenders will be opened for the construction of a railway between Kieldrecht and Doel, at the estimated cost of about £4,000.

Peru.

The Board of Trade have received from H.M. Minister at Lima, copy and translation of a Law regulating the tenders to be offered to the Peruvian Government, within one hundred and twenty days from January 14th, for the construction and working of the projected railway between Lima and Piscc.

The maximum capital necessary to carry out the work is estimated at £500,000, on which the Peruvian Government guarantees interest at the rate of seven per cent. per annum to the contractor, during twenty-five years from the day that the principal line is handed over to public traffic.

To guarantee the execution of the contract, the sum of ten thousand pounds, Peruvian, or its equivalent in bonds, must be deposited before signing the deed, and no tender will be accepted unless it is accompanied by a receipt showing that ten per cent. of this amount has been deposited.

Portugal.

Tenders will be opened on May 24th in the Directorate of the Caminhos de Ferro Ultramarinos, for the exclusive concession during fifteen years, for running automobiles for the transport of persons and merchandise from Mossamedes to Chibia. The tenderers must be Portuguese citizens or companies,

Ottoman Empire.

There will shortly be an opening for agricultural machinery in Turkey. The Turkish Government have decided to allocate an annual grant of £T3,000 (£2,700 sterling) for the encouragement of agriculture in the districts of Samsoun, Angora, Sivas and Konia. Half this sum will be devoted to the purchase of agricultural machinery.

Mexico.

A contract has been made between the State and Don Wenceslao Garcia for the construction and working for ninety-nine years of a railway of 9·14 mm. gauge, in the State of Oaxaca, from the capital of that State to Tlacolula with a branch to Tlalixtac. The period for free importation of materials and supplies, to which Article 74 of the Railway Law refers, is to be five years.

Argentina.

Tenders will be opened on April 15th next, in the Ministry of Public Works, Buenos Ayres, for the construction of the prolongation of the railway and buildings corresponding thereto, supply of rolling stock etc., from Chambicha and Rioja to Andalgalá, with a branch from Mazan to Tinogasta, on the terms which those interested may consult in the Directorate-General of Ways of Communication, Buenos Ayres.

The right to build and work a railway line, either 1 metre gauge or 1·66 metre gauge, from the port of Rosario on the River Paraná, to the port of Belgrano on Bahia Blanca, has been granted to Don Diego de Alvear, according to the plan which the Government may approve. Materials for the construction of this railway not produced in the country may be imported free of duty for twenty years from the date of the contract, during which period, moreover, the line is to be free of national taxes.

The French Railway Company, of the province of Santa Fé, have the right to construct and work a metre gauge railway line from the "La Sábana" station to the port of Barranqueras, on the River Paraná passing through the town of Resistencia, as well as a wharf, warehouses, etc., in the port of Barranqueras. Materials for the construction and working of this railway which national industry does not produce may be imported free of duty.

Cuba.

The Directorate-General of Communications, Havana, invites tenders by April 15th for the establishment and working of a telephone system in the town of Guantánamo. A provisional deposit of 200 dols. is required to qualify any tender.

Spain.

The towns of La Solana and Membrilla, province of La Mancha, require tenders for the supply of electric light for twenty years. In the case of La Solana the municipality require to be supplied with 2,000 c.p. and will pay 6,000 pesetas (about £173) per annum as a maximum, whilst in the case of Membrilla the municipality require 1,250 c.p. and will pay at the rate of 4,000 pesetas (about £116) per annum as a maximum.

There is a demand for tenders, which will be opened on April 9th in Malaga, for the concession to construct and work an urban tramway by animal power from the station of the Malaga and Cordoba railway to the working-class suburb of Huelin. In the same municipality, on April 4th, tenders will be opened for a concession to establish and work a tramway by animal power from the Plaza de Riego to Calle de Torrijos. A Royal Order has been issued requiring that the calls for tenders for the establishment of telephone systems in El Escorial and Palamós, which were suspended by the Royal Order of September 9th last, shall now be renewed at the earliest date possible.

OUR TECHNICAL COLLEGES.

BY

A TECHNICAL STUDENT.

THE SUGGESTIVENESS OF STUDENTS' PAPERS.

Professor A. C. Elliott, D.Sc., of the University College of South Wales, Monmouthshire, Cardiff, sends me an excellent suggestion to the effect that these columns might with advantage contain occasional reports of the College Engineering Societies. "Our society," says Prof. Elliott, "has been going for more than ten years. It recently paid a visit to the Severn tunnel pumping station and arrived on the ground to see the biggest output for 27 years—viz., 34,000,000 gallons in 24 hours." He further remarks that long ago the Institution of Civil Engineers recognised the claim of the student class to a representation in the proceedings, and the foresight has been amply justified. Says Prof. Elliott: Students' papers are, as all who have had any experience will vouch, extremely suggestive, and the errors simply set older men thinking of the days when they were young, not usually a wholly unpleasant experience. I welcome the suggestion and shall be glad to act upon it. Secretaries of College Engineering Societies are hereby invited to co-operate.

"THERMOTECHNICS" AT THE CITY AND GUILDS' TECHNICAL COLLEGE, FINSBURY.

During the past three years the course of instruction in "Heat" for evening students, at the City and Guilds' Technical College, Finsbury, has been modified so as to bring the subject more into touch with workshop practice. As by far the greater portion of the students attending the lectures and laboratory are connected with engineering trades, the value of a thoroughly practical course in this subject is manifest. The lectures have been devoted, firstly, to the general principles of the science, and afterwards to such matters of commercial import as refrigerating machinery and cold storage; properties and evaluation of the different classes of fuel; steam boiler economy and the properties of steam; modern pyrometry and its applications; and the consideration of steam and other engines from the standpoint of thermodynamics. The lectures throughout have been illustrated by experiments, and diagrams or lantern slides of the actual appliances used in workshops or factories. In the laboratory, the preliminary work has been devoted to the determination of the various thermal constants, such at co-efficients of expansion; specific and latent heats, etc., so as to familiarise the student with practical methods of determining heat quantities accurately. The more advanced work has consisted in the determination of the calorific value and other properties of fuels; the comparison of different heat insulators; the standardising and use of a thermal-couple pyrometer; finding the connection between the temperature and pressure of saturated steam; and the determination of the vapour pressure of volatile liquids, such as petrols, ether, etc., with a view to finding the conditions for the safe storage of these liquids.

The course, as outlined above, has proved to be extremely successful with the class of students attending the College, and a greatly increased attendance has resulted. With the advantage of a more commodious heat laboratory in the proposed extension of the buildings, greater facilities will be afforded for carrying out this scheme of instruction, which could, no doubt, be copied with advantage by other institutions conducting evening classes for engineering students. The lectures and laboratory work have been conducted by Mr. C. R. Darling, A.R.C.Sc.I., Wh. Ex., under the direction of the Principal of the College, Dr. Silvanus P. Thompson, F.R.S.

MINING LECTURES IN THE SHEFFIELD DISTRICT.

In a recent report on the work of the Mining Department of the University College of Sheffield, Professor Hardwicke points out that although previous to the Session 1891-1892 several courses of lectures on "Mining" had been delivered at the college by Mr. Blake Walker and Mr. Cobbold, no organised department had been attempted. "The work of the present department," he says, "commenced in October, 1891, and consisted then of a first year's Saturday Afternoon Course in mining, for which thirty exhibitioners from the West Riding and Derbyshire County Councils were entered, of a large number of peripatetic lectures in the West Riding and in Derbyshire, and of a share in the Barnsley mining classes.

After reviewing the history of these lectures during the preceding years, he remarks:—

"In the Session 1896-1897 our present 'Advanced' course for day students was commenced; arrangements were made by which articled pupils and others who could spare the time could attend the College two days per week for three years.

"In the Session 1897-1898 the class for mining teachers was commenced. The permanence of the local classes in Derbyshire had been established, and the West Riding County Council were preparing to arrange for similar classes, but it was felt that the teachers of these classes (who as a rule were and are men actively engaged in colliery work) needed some training in the art of teaching; this class was therefore instituted to meet this need. The number of West Riding peripatetic lecture centres was reduced to seven, and in the following Session to four. In this Session the connection between the Barnsley Mining Class and the Colleges was severed, and Barnsley became a local centre instead of a collegiate course.

"In Session 1898-1899 the local centres in 'Mining' were commenced in the West Riding, and the college was entrusted with the inspection, organisation, and examination of the classes.

"In the Session 1899-1900 the Saturday afternoon class in 'Electricity applied to Mining' was established. The Derbyshire County Council arranged to grant ten exhibitioners for this course, and this enabled us to make a start; in the present Session the West Riding County Council has also given its support to this class.

"In conclusion, I must point out to you how greatly we have been aided in our work by the hearty co-operation and goodwill of the County Councils of the West Riding and Derbyshire. Apart from the fact that the department is entirely supported by their contributions, we have always worked on the best of terms with them and their representatives; any suggestions we have made have been readily met, and we have been assisted by them to branch out into new lines of work to meet fresh needs which have from time to time arisen."

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

TRANSATLANTIC ENGINEERING SCHOOLS.

THE paper on Transatlantic Engineering Schools and Engineering, by Dr. R. Mullineaux Walmsley, which forms the basis of criticisms by Mr. E. C. de Segundo in the present number, was contributed to the Institution of Electrical Engineers, and is a lengthy document, including a valuable collection of facts and figures regarding technical education in the United States. This information was obtained last year in the course of a tour by Dr. Walmsley undertaken at the instigation of the Governors of the Northampton Institute. Altogether, about thirty-four universities, colleges and schools, and forty-eight factories were visited, numerous interviews being held with business men.

Many of the universities visited possess fine buildings situated in extensive grounds, and the engineering department is usually prominent. The workshops, as a rule, are lavishly equipped, and the laboratories even more so. Manufacturers are very generous in their gifts to the colleges, one firm building a special full-sized locomotive, which was presented to a college for testing purposes. The electrical laboratories cannot be extended fast enough to accommodate the increase in the number of students, but they are equipped throughout with modern and efficient apparatus and machinery.

For electric traction work the University of Illinois at Urbana has, in conjunction with the Illinois Central Railway Company, built and equipped an experimental car which can be attached to any train so as to furnish data obtained under actual working conditions. The car was provided by the railway company, and equipped with its instruments and fittings by the university. The Brooklyn Polytechnic is allowed from time to time by the local street railway company to use part of its track for experimental work, the company supplying the necessary current and an operating staff.

TEACHING STAFF.

It is recognised in the United States and Canada that in addition to sound academical training the teachers should possess considerable experience as engineers. It is not the men who have been in practical life and have failed that are wanted, but men who have had practical engineering experience and have been successful in it. Even with the large resources at the disposal of the colleges, however, their present financial position is not strong enough to enable them to offer the salaries for heads of departments which the necessities of the case require. It is the universal custom to *require* teachers to engage in outside consulting work.

FINANCES.

From a financial point of view the transatlantic engineering colleges appear to be on a better footing than those in England. Although a considerable amount of money is given in large sums by millionaires, the extent of the smaller contributions from a great number of individuals does not seem to be realised. In the year ended August 31st, 1902, a sum not far short of £100,000 was received by the University of Pennsylvania from private donors. These donors numbered about four hundred separate individuals and although there are one or two large amounts, including one of £10,000 and another of £5,000, the bulk of the money came from the large number of much smaller contributions. There was also a single donation of £100,000.

STUDENTS AVAILABLE AND CONDITIONS OF ENTRANCE.

The basis of the American and Canadian educational system is the common or public school which the child enters at the age of six. At ten he is transferred to the grammar school, which forms the intermediate stage between the primary and the secondary school. Here he remains for four years, and learns very little beyond elementary English and arithmetic. Such students as can then afford to pursue their education to a higher level enter either the high school, with its classical and modern side, or the manual training high school or manual training school, in which workshop instruction forms a large part of the curriculum. At this stage the usual courses extend over another four years, but in some of the manual training schools they cover only three years; generally, therefore, by the time the student has gone through the whole course he is eighteen years of age. These schools take charge of the stage of education which is immediately preparatory to the entrance to the universities and technical colleges, but the majority of the pupils do not carry their education further, but pass direct from them into ordinary life.

Taking first the manual training high schools and the manual training schools, a large proportion of the time, often approximating to one-third of the whole, is spent in the workshops, the remaining time being given to mathematics, drawing, science, literature and modern languages. In the high schools, on the other hand, there is a classical course, and often, in addition, what we should call in this country a modern side, in which modern languages and science take the place of Latin and Greek. Mathematics is, of course, taught in all sections of the school. Under certain conditions, the student is permitted to choose for himself the subjects which he intends to study, and the author does not consider this advisable.

Students for the classical sides of the high schools frequently make better engineers than those who have gone through the manual training schools.

Owing to later age of entrance and to their general education having, as a rule, been carried to a higher point, the candidates for technical courses in America are more able to take advantage of the training than their English cousins. The American navy, army and civil service do not prove such formidable competitors as the corresponding British services in the demand for men who would otherwise take up engineering. Many students in America are men who have had to support themselves from a comparatively early age, and who, after saving up sufficient money, often go through a four years' course when well on in life. Entrance of students under eighteen years of age to technical institutions is strongly discouraged. In nearly all cases an entrance examination is set, which is more difficult than the matriculation examination of the University of London. English is a compulsory subject in every instance, but there is a certain amount of variation regarding other subjects in the different schools. There is a tendency, in institutions of good reputation, to still further raise the conditions of entrance, this being due to the fact that the increasing number of candidates is severely taxing their resources and accommodation.

FEES.

Fees for tuition range from nothing up to £52 per annum, according to the locality and status of the school. The highest fees are charged at the eastern universities, but tuition is practically free to residents in the middle-west States, as these latter derive a considerable part of their income from the State. There are a great number of free scholarships in connection with several universities. The cost of living is comparatively low at Canadian institutions.

It seems to be a common opinion that four years is insufficient for the work to be done, and there is a movement on foot either to give a longer preliminary training or to lengthen the time spent in the professional school. Although the age of entrance is late, the preparation is not so good as it might be, and an attempt is made to remedy this state of affairs by devoting a large amount of time to teaching non-professional subjects during the first two years, thus crowding much highly technical work into the remaining two years.

POST-GRADUATE COURSES.

A complete statement is given of the total number of hours devoted to different subjects in several institutions. In most of the colleges post-graduate courses of a very elaborate nature are organised, the student is allowed to select his particular line of work, and the full resources of the laboratory, together with the help of the professorial and artisan staff, are placed at his disposal. Much very valuable work has emanated from these courses. In the sixteen institutions which Dr. Walmsley discusses there were as many as 1,134 students doing fourth-year work, and 237 post-graduates students

EMPLOYMENT FOR GRADUATES.

Inquiries among principals and employers revealed the fact that there is never the slightest difficulty in finding remunerative employment for graduates, indeed many of the latter secure appointments before their course is completed. The premium system is practically non-existent and the large firms start graduates at a living wage, at the same time giving them every opportunity to improve their position.

Another direction in which the employers help the colleges is in practically throwing open their workshops during the summer vacation for the undergraduates to obtain workshop practice under commercial conditions. No undergraduate who is willing to work need be at a loss in America to find a shop in which he will be welcomed and given every reasonable facility. The firms giving such facilities say that they are amply repaid by becoming acquainted in advance with the real value of the men who are graduating, and in the data they require for making their selection when the time comes.

TECHNICAL EDUCATION IN ENGLAND.

Modern trade developments are moving so rapidly that, for the moment and until the reform of secondary education, now so strongly advocated, have been accomplished, the author considers it would be disastrous to stand still. We must press forward our technological education and make the best of the materials which are available. At any rate, a proportion of the secondary education which is being given is good, and we shall obtain at least some students who are well fitted to take advantage of more than all that we can put before them. He advocates the abolition of the premium system, the better equipping and staffing of the technical schools, more encouragement at home for graduates—the adoption of some form of the sandwich system—and wider knowledge than college training is absolutely essential. The employers and manufacturers hold the key of the position.

THE WAGON PROBLEM.

At a meeting of the Institute of Civil Engineers, Sir William H. White, K.C.B., president, in the chair, papers were read on "The Construction of Railway Wagons in Steel," by J. D. Twinberrow, Assoc.M.Inst. C.E.; "The Construction of Iron and Steel Railway-Wagons," by A. L. Shackleford, Assoc. M.Inst.C.E.; and "Iron and Steel Railway-Wagons of High Capacity," by J. T. Jepson. The following are abstracts:—

MR. TWINBERROW'S PAPER.

The first paper begins with a comparison of the physical qualities of timber and steel. The limit of elasticity of white oak is nearly equal to the ultimate strength, and the modulus of elasticity is low, so that a timber frame, by reason of the extent of its elastic deflection, has great capability of absorbing shock. The lateral stiffness of planking is greater than that of unstiffened steel plates of equal weight. The joints of wooden frames are a source of weakness. Rectangular sections are alone practicable for timber beams; the safe load on a rolled joist is compared with that upon an oak beam of similar depth, and the section and weight of beams of equal strength are compared.

In British practice solebars, headstocks, longitudinals, and transoms are usually of similar section; in Continental practice the inner members are shallower than the soles, crossing above or below each other, thus simplifying the joints at points of intersection. The ratio of the load-gauge to rail-gauge is considered; the inadaquacy of the former is stated to be due to the restrictive influence of the design of rolling stock with rigid wheel-base.

The use of bogie trucks is considered to be desirable when the weight on the axles is increased; the adoption of bogie lead or apparatus to control the lateral and angular deflection of bogies is recommended. Bearing-springs in series are to be preferred to single springs of greater flexibility. The practice of arranging the side frames of the bogie and the axle-box springs and axle-guards in the vertical plane through the centres of the journals is preferred to the usual European practice of setting back the frames and axle-guards to provide room for laminated springs over the axle-boxes.

Designs were illustrated as an embodiment of the idea that a steel wagon should be a complete structure, in which all parts necessary for containing the load contribute to the strength and stability of the whole, whilst the component parts are plain rolling-mill shapes of standard section, assembled without the aid of special forged or pressed work.

The sides of the wagons are formed of plate girders, of which the depth is so considerable, in relation to the span, that deflections under working load are quite inappreciable.

Special stress is laid upon self-discharging vehicles, on account of the great economy effected by their use in the manipulation of minerals and other bulk freight at terminals. The ends of these wagons and the lower parts of the sides converge to openings at a suitable height above the rail-level. A special form of door which travels on horizontal guides is described; the prominent features of these doors are the facility they afford for providing a long base line for intersection of the end slopes, their security against accidental opening, and the ease with which they may be closed to retain any desired portion of the load.

Hand-brakes are operated by means of a screw with pull-rods connected so as to transmit the pressure to each wheel of each bogie, and to permit of the coupling up of air or vacuum-cylinders as required.

The defective action of ordinary side buffers with screw couplings on sharp curves is mentioned, and the conditions for eliminating it are noted; central couplers are referred to; and the capacity of friction draft-gear is compared with that of the standard buffing and draw-gear of private owners' wagons.

The practice of weighing long wagons on short weigh-bridges is also alluded to.

THE CONSTRUCTION OF IRON AND STEEL RAILWAY WAGONS.

The second paper, by Mr. Shackleford, deals in the first place with the advances made in the construction of railway wagons during the last thirty or forty years, detailing the successive steps from the wagon built entirely of timber, which was in vogue at the commencement of that period, down to the latest form of wagon made entirely of iron or steel, and the advantages accruing from this form of structure. The author compares the strength of timber and metal, and shows that for a 10-ton wagon built to the English standard regulations, a steel frame can be made much lighter than a timber frame to carry the same load; while the strength of the timber frame is not to be compared with that of the steel frame.

He describes the changes that have taken place in the form of construction of steel underframes and bodies. A great advantage of steel frames is the ease with which the various members can be replaced, owing to all drilling and machining being done either with steel-bushed templates, or by means of multiple drills and other modern metal-working machines, so that complete interchangeability is ensured.

Another point of great importance is the protection of iron and steel plates, channels, angles, etc., from rust and subsequent corrosion; and he points out that wherever practicable this should be accomplished by a coat of boiled oil, or of some suitable paint, as soon as possible after the metal has left the rolls. The omission of this precaution is frequently attended with disastrous results, as when once corrosion has been set up the metal is very soon destroyed, and in a short time it is useless for all practical purposes. The author lays particular stress on this point, as the very existence of the wagon depends upon it. On the other hand, when a metal wagon has been well taken care of and properly painted from time to time, it has been proved that the loss through corrosion is insignificant, and the wagon may be expected to last several times as long as one built of timber, for no amount of attention and painting will preserve timber for anything like the same length of time.

The author points out that although the cost of a metal wagon is at present somewhat higher than that of a timber wagon, the action of the Engineering Standards Committee in arranging certain approved sections will tend to reduce it greatly; and it may be expected that before long a wagon built of iron or steel will be produced at the same or even at a lower cost than one built of timber. With regard to the question of whether a large bogie-wagon or a four-wheeled wagon would be more economical for carrying goods on English railways, the author gives his opinion in favour of the smaller wagon, pointing out that loads in England are frequently too small, and the distance to be run too short, to allow of the use of a larger wagon; in fact the average load which it is convenient to put in an English wagon averages under 5 tons.

A table giving a comparison of the ratio of load and tare for some of the principal wagons built under the author's supervision shows that the tare of a wagon built entirely of steel is much lower per ton of load than that of a wagon built entirely of timber.

THE HIGH-CAPACITY PROBLEM.

In the third paper, by Mr. Jepson, the wagon problem as affecting English railways is first considered, and a list is given of the companies which are using and experimenting with wagons of higher carrying capacity.

The advantages of high-capacity wagons for coal-traffic are shown by the saving their use will effect in the tare or non-paying load, and in the lengths of trains; and the difficulties in the way of their introduction, both at the collieries and at the points of discharge, are dealt with.

The wagons described in the paper are designed for the conveyance of coal, and are suitable chiefly for traffic on the British railway systems. Several of the examples are of wagons already built and in traffic, which are proved in every way satisfactory, and have a lower tare than any other of the same class. They are all constructed of iron and steel, and are fitted with an either-side hand-screw brake, the self-discharging wagons having either-side door-operating and locking gear.

The questions of the limit to the carrying capacity of bogie coal-wagons for traffic in this country, and the most convenient size, are fully discussed, taking into consideration the limited load-gauge, the sharp curves, and the fact that the wagons have to be provided with corner buffers. The difficulty of using screw-couplings for these wagons is dealt with, and some examples are cited of large coal-wagons of the bogie type in use in the colonies. A tabulated list is also given of the bogie coal-wagons at present employed for traffic in Great Britain.

Proceeding to details of construction, the first example given and that with the lowest tare compared with the measurement load, is a 40-ton coal-wagon of the flat-bottomed type, arranged for discharging by hand-labour through opening in the sides. Although fitted with laminated bearing springs, this wagon is shown to be the lowest in tare of various constructions, and at the same time exceedingly strong.

An important section of the paper is devoted to the construction and details of self-discharging wagons for the conveyance of minerals. The first example is a 40-ton wagon arranged so that the contents are discharged down a shoot between the rails, the mouth of the shoot being limited in length. A comparison is made between the work of receiving and discharging one of these wagons and wagons of the ordinary 10-ton type to carry the same amount of coal. Details of a test of two and a-half times the maximum working load, which was carried out on one of these wagons, are given and also the time taken to discharge 40 tons of coal.

Other examples are given of a 40-ton wagon of similar construction to the foregoing, but arranged to discharge its contents between the rails at three given points; an 80,000 lb. wagon for a 3 ft. 6 in. gauge railway, fitted with central buffers and arranged to discharge its contents outside the rails; a 100,000 lb. wagon, arranged to discharge part of its contents near the centre, and part near the ends of the wagon; and a 20-ton four-wheeled wagon arranged to discharge its contents between the rails at the centre of the wagon, and having a 10 ft. wheel-base, and less tare than any 20-ton flat-bottomed wagon in use.

Designs for 60-ton and 70-ton wagons arranged to discharge their contents between the rails are also outlined, showing the load it would be possible to carry with an increased load-gauge, such as that adopted in the United States and other countries.

TECHNICAL EDUCATION AT HOME AND ABROAD.

A USEFUL paper on Technical Education in which special reference is made to the Admiralty system, was read by Mr. B. C. Laws at a meeting of the North-East Coast Institution of Engineers and Shipbuilders. In his introduction, the author remarks that :—

One cannot but think that the engineer has generally speaking received meagre recognition in the world of science until comparatively recently.

The essentially practical man, who hitherto has more or less built up his fortunes unaided by scientific knowledge, has frequently derided the idea of education, and innumerable instances could be cited where it has been a positive disqualification for an applicant for a post to reveal that he held an educational diploma. In consequence progress has been retarded, and the rightful recognition of a place for engineering amongst the learned professions has been delayed.

The author proceeds to comment upon the beneficial work done by the Institution of Civil Engineers in fixing the necessary preliminary education and the scientific training of engineers. He also summarises the progress made in our universities, colleges, and technical schools.

RELATIVE VALUE OF SCIENTIFIC TRAINING

In claiming for engineers the highest possible recognition in the world of science, the author does not detract in any way from the value of practical experience.

The highest scientific training obtainable can never produce an engineer, unless the particular individual knows by intimate contact with the practical side of his profession how to apply or even modify, if needs be, his theory to meet all the demands.

Theoretical knowledge is in no sense a substitute for practical experience, but the two judiciously combined can alone make the man able and ready to cope with the intricate problems which from time to time present themselves.

THE ADMIRALTY SYSTEM OF EDUCATION.

Giving a history of the Dockyard schools, he remarks that one of the greatest monuments to the efficiency of these schools is our modern Navy.

Such concurrent practical and theoretical training it is impossible to overestimate, and it appears to be the best solution to the question of the technical training of engineers.

While great credit is due to all who have so well maintained the honour of these schools, it must not be forgotten that in a great measure the success attending the training as in all instances of systematic instruction, must be largely attributed to those who have the responsibility of imparting the instruction.

The masters are selected by open competition, and with perhaps a few exceptions it has resulted in an Admiralty-trained candidate being successful often against highly trained men from our best universities and colleges.

From the beginning the schools have been run on the most economic lines both in point of the salaries paid to the teachers and of equipment of essentials necessary for the students. This may be readily seen by comparing the cost of upkeep not only with that of any other teaching department of the Navy, but with that of our technical institutions covering the same range of teaching.

With the recent appointment of Professor Ewing, F.R.S., as Director of Naval Education, it is hoped that the training of the young men in all departments of the service will be still further advanced. At the present moment he is engaged in the work of reorganisation where necessity requires it, and the energy already displayed by him is sufficient evidence of the important place which he considers these schools should occupy.

POSITION OF NAVAL ARCHITECTURE.

Discussing technical education in general, the author remarks that most of the branches of engineering are well represented in the majority of our technical institutions; naval architecture, however, upon which the growth of this Empire may be said more or less to have depended, has not been justly considered. Excepting the Royal Naval College, where a professional instructor is appointed from the Admiralty and the chair of Naval Architecture at Glasgow University, no other separate chair in this subject appears to exist, and this in a country eminent for shipbuilding and marine engineering.

When we sympathise with education—and especially technical education—as America and Europe do, we shall be able to hold our own against our competitors. No effort should be spared to obtain every advantage that a high technical training could give, and the best opportunities should be afforded those who had the best abilities.

(*To be continued.*)

BOOKS OF THE MONTH.

"THE METALLURGY OF STEEL."

By F. W. Harbord, Assoc.R.S.M., F.I.C., with a section on "The Mechanical Treatment of Steel," by J. W. Hall, A.M.Inst.C.E. Charles Griffin and Co., Ltd. 25s. net.

The literature of iron and steel has received a notable addition in "The Metallurgy of Steel," by Professor F. W. Harbord, Assoc.R.S.M., F.I.C., which forms one of Griffin's Standard Metallurgical Series. The author has gripped his subject in a masterly manner, and the outcome is a wonderfully comprehensive volume, replete with interest and invaluable both as a text book and work of reference.

A brief analysis of the work shows that it is divided into four parts. (1) The Manufacture of Steel; (2) Reheating; (3) The Mechanical Treatment of Steel; (4) Finished Steel For the major portion, Professor Harbord is responsible, but Section III. has been handed over to Mr. J. W. Hall, A.M.Inst. C.E., whose special experience has enabled him to deal with the subject in a thoroughly practical manner. A feature which impresses itself upon the reader at an early stage is the excellence and frequency of the illustrations, comprising 37 folding plates, with 178 figures, some 280 illustrations in the text and nearly 100 micro-photographs of steel sections.

In the first section, dealing with the plant, machinery, methods, and chemistry of the Bessemer and the open hearth processes (acid and basic), special attention is given to recent steel plants in the United States and on the Continent, the latest types of steel furnaces, gas producers, etc., being carefully described and drawn to scale.

Discussing the Talbot continuous process, the author remarks that practically all processes that have been introduced to increase the output and improve the yield of the basic open hearth process have depended upon the use of fluid metal, with large additions of oxides, and the difficulty has always been to prevent the destruction of the hearth by the combined chemical action of the oxides and the mechanical abrasion of the fluid metal when poured into the furnace.

This problem of the treatment of fluid pig-iron of more or less irregular composition, as regards silicon or phosphorus, has been most effectively attacked by Mr. Benjamin Talbot, of Pencoyd, in what is known as the continuous open hearth process, which promises to be a great success. In this process a basic-lined tilting furnace is used, especially designed so that any quantity of slag and metal can be poured off at any time during the working of the charge, and also that large or small additions of oxidising agents, limestone, or metal can be added. The process of working is as follows:—Liquid metal, either from a blast furnace mixer or a cupola, is conveyed in ladles and poured, by means of a spout, into a tilting furnace of the Wellman or Campbell type; large additions of oxide and limestone are added, by means of a Wellman charger, and the whole charge worked down as rapidly as possible by further additions of oxides and limestone, from time to time. When finished, the greater bulk of the slag is poured off through a slag notch on the charging side, and then a *portion only* of the metallic charge, varying from 10 to 33 per cent. of the total weight of metal in the furnace, is poured off into a ladle, Ferro-Manganese added in the usual way, and the steel teemed into ingot moulds. Additions of oxide and limestone are now charged into the furnace, and then molten pig metal, equal in quantity to the finished steel tapped off, is poured into the furnace. A very vigorous reaction at once takes place between the impurities in the metal introduced and the oxidising slag, whereby the C, Si, P, and Mn are rapidly oxidised, and equivalent amounts of iron are reduced from the oxide in the slag, and pass into the metal bath. In working hematite metal, or metal low in phosphorus, the heat of the furnace is maintained as high as possible, as then the carbon and silicon are much more rapidly eliminated. On the other hand, when working high phosphoric irons, the temperature of the furnace is reduced as low as possible, consistently with maintaining the bath of metal in a fluid condition. Under these conditions, the phosphorus is eliminated before the carbon, and the highly phosphoric and silicious slag can be poured off, and fresh basic and oxidising agents added to form a pure finished slag, and so rapidly remove the carpon. Silicon is so rapidly removed that a few minutes after charging the molten pig metal, even when using large additions, equal to one-third of the bath, the metal in the furnace contains only traces. The ease with which the slag can be removed enables a very irregular metal to be used, as if the slag should be very silicious, it can be poured off before it can seriously attack the lining of the furnace. By the device of keeping the furnace hearth always two-thirds full of molten metal, the fluxing action of the slag on the basic lining is confined to a few inches above the bath of metal on which it floats, as it never comes near the bottom of the furnace, except when the furnace is being emptied at the end of the week. Thus a slag which, in the ordinary method of working the Siemen's process, would almost destroy the bottom of a basic furnace, has no appreciably destructive effect on the lining when the furnace hearth is protected by a bath of molten metal.

The work abounds in hints of value to the practical man. Take for instance the following on running stoppers when steel is being cast into ingots: Ingot moulds must not be filled too rapidly, or they will rise and "pipe"; and, on the other hand, if teeming is done too slowly, there is a very fair chance of never filling them at all, as the metal will probably set round the nozzle of the casting ladle. Sometimes a small piece of metal setting in the edge of the nozzle outside will divert the stream from the vertical, and cause it to splash on the sides of the ingot moulds, but generally a sharp-pointed bar and a skilful man will remove this. In the event of a running stopper—*i.e.*, a stopper which refuses to shut close—little can be done except to move the ladle as rapidly as possible from mound to mould, and to see that the pitmen remove the scrap from the top edges of the moulds the moment they can get near. In the case of metal partially setting in the nozzle, it may often be removed by one man holding a sharp-pointed bar, with the end bent up at right angles, under the nozzle, while another drives it into the nozzle with a sledge, and then rapidly knocks it out again. This is one of those practical things which must be done very quickly and skilfully if it is not to do more harm than good, and is a distinctly dangerous operation for a clumsy man to attempt. If this is not successful the only thing to do is to remove the nozzle-box on the bottom of the ladle, and knock the nozzle out, when the steel must be caught in the moulds as best it can. This is rarely successful, and frequently ends in spoiling several moulds by covering them with molten steel, and it is generally better to tip the ladle and pour the steel into one corner of the pit.

Or again—this time on the subject of gas producers: —Nothing is probably of greater importance in fuel economy than keeping a regular and systematic check upon the working of the producer by frequent analyses of the coal used, the ashes, and the evolved gas, as it is not an uncommon thing to find producers working under similar conditions as regards fuel varying in efficiency from 50 to 66 or 75 per cent., which means that one producer is burning 70 tons of fuel to produce the same amount of heat as the other is producing from only 50 tons. In some American works, samples of gas are taken from the producer once or twice every twelve hours, an average sample from the main gas culvert every two hours, and the whole results tabulated and plotted each week. The cost of this is only equal to a few tons of fuel per week, and, if this example, combined with frequent analyses of ashes, etc., were followed in all our English works, the saving in fuel would probably astonish some of our steel makers.

Under normal conditions of work, when an average amount of steam is used, as in the Siemens, Wilson, or Dawson type of producers, carbonic acid should average about five per cent., and should never exceed seven per cent. A higher percentage than this, especially if the gas has a high temperature on leaving the producer, may be taken as a sure indication of bad working.

Mr. Hall's section is also intensely practical and to the point. A useful feature is included in the shape of bibliographies, so that those who wish to look further afield have every opportunity of doing so. Mention should be made of the excellent series of photomicrographs. There are many valuable pages concerned with micro-structure, special steels, testing specifications, etc.

"BRITISH INDUSTRIES UNDER FREE TRADE."

Essays by Experts.—Edited by Harold Cox, Secretary of the Cobden Club. T. Fisher Unwin. 6s.

Have British industries flourished under free trade? The question goes to the heart of the fiscal controversy, and in stating the case for free trade, an attempt is made to answer it by collecting the opinions of a certain number of practical business men, each of whom deals with the industry which falls within his own particular phere.

Mr. M. L. Davies (of Messrs. Alfred Holt and Co.) deals with "Shipping Liners," and Mr. Walter Runciman, jun., M.P., with "Tramp Shipping." The Iron and Steel Machinery and Engineering, and Coal Trades are respectively called upon for evidence by Messrs. Hugh Bell, Arthur Wadham, A.I.Mech.E., and D. A. Thomas, M.A., M.P. The remaining industries discussed are the "Cotton Industry," by Mr. Elijah Helm; "The Woollen Industry," by Sir Swire Smith; "The Linen Industry," by Sir R. Lloyd Patterson; "The Silk Trade," by Mr. Matthew Blair (chairman of the Incorporated Weaving, Dyeing, and Printing College of Glasgow); "The Development of British Banking," by a Practical Banker; "The Cutlery Trade of Sheffield," by Mr. Frederick Callis; "The Tinplate Trade," by Mr. W. Llewelyn Williams, M.A., B.C.L.; "Confectionery and Preserve-making Industries," by Mr. Robert Just Boyd; "The Grocer's Industry," by Mr. J. Innes Rogers; "The Paper Trade," by Mr. Albert Spicer; "The Alkali Industry," by Mr. Alfred Mond (of Messrs. Brunner, Mond and Co.); "The Soap Industry," by Councillor A. H. Scott; "The Boot and Shoe Trade," with a "Note on the Leather Trade," by John T. Day (editor of the "Shoe and Leather Record"), and "Flour Milling Under Free Trade," by Mr. Andrew Law (of Messrs. Crawford and Law, Glasgow).

These essays should be read impartially by free trader and protectionist alike. The authorship alone stamps them with authority, and when we add that they are thoroughly readable, it will be understood that they are on a higher plane than much of the "literature" on the fiscal question with which the public has lately been assailed.

"LABOUR AND PROTECTION."

A Series of Studies. Edited by H. W. Massingham. T. Fisher Unwin. 6s.

Here again we have a collection of essays designed to proclaim the benefits of free trade. Mr. John Burns, M.P., leads off with "Political Dangers of Protection," in good fighting style, and his argument has much that is at once pungent and instructive. Though we do not wish to enter into political matters, we cannot refrain from quoting the following, which gives a good idea of Mr. Burns' "straight from the shoulder" style:—

"England has more than its equitable share of the world's work, and the pity of it is that so much of the product of its energies should be wasted in war, where it is not misspent upon drink or gambling, betting and luxury. A nation that spends £180,000,000 a year on drink, £70,000,000 on war, and £50,000,000 on horse-racing and betting need not tax the food of its poor or exclude the cheap sugar of foreign countries because it wishes to raise a few millions of revenue, or to help its Colonies. Here, in three branches of its wasteful expenditure—drink, war, gambling—lies the total amount of its export trade with the Colonies and the world. Here is a true margin for economy. Within these bloated figures are the means of Old Age Pensions, extended trade, diminished burdens, increased health, vigour, and capacity for all classes of the community."

The remaining essays make interesting reading, and are grouped under the following suggestive headings:— "Protection as a Working class Policy," "In the Days of Protection," "The Workman's Cupboard," "The Co-operative Housewife," "The People on the Margin," "Protection in the Staple Trades," "An Object-Lesson from Germany."

"THE CYANIDE PROCESS OF GOLD EXTRACTION."

A Text-book for the use of Mining Students, Metallurgists, and Cyanide Operators. By James Park. Third English edition, revised and enlarged. With frontispiece, plates, and illustrations. Charles Griffin and Co., Ltd. 7s. 6d.

This well-known handbook has now reached its third English edition. It is an authorised text-book in use in the Australian Schools of Mines, and it should be stated that the first English edition was revised and enlarged from the third edition published in New Zealand. The author has taken the opportunity of adding some valuable data relating to the lead smelting of gold slimes, the treatment of sulpho-telluride ores and filter press practice. Special mention should be made of the numerous folding plates, which are of the highest possible interest to students of cyanide practice. The frontispiece shows a mammoth cyanide plant in use in the Transvaal.

ANALYSES OF BRITISH COALS AND COKE.

The Colliery Guardian Company, Limited, 30 and 31, Furnival Street, London, have just issued the third part of a series of analyses of British coals and coke, which is appearing in the columns of the "Colliery Guardian." In collecting these analyses the object has been to classify them in districts over the coalfields of Britain, and they should prove of great value to those connected with the trade, either in a productive or in a commercial capacity.

OUR DIARY.

February.

22nd.—Great loss of life and destruction of several villages in China, consequent upon the bursting of a dam across the river Hwange-ho.—Navy Appropriation Account 1902-3, issued as a Parliamentary paper.

23rd.—Compared with the corresponding period of last year, the Cape Colony revenue returns for the seven months of the financial year show a decrease of £700,000.

24th.—The Egyptian revenue 1903 amounts to £E 12,463.700; the expenditure £E 10,595.979, which includes for the first time the charge of the reservoir annuity, half of which, £E 75,648, was paid in 1903.

25th.—*Lake Michigan*, the steamer which was recently beached near Dover is refloated and towed into the Thames.

26th.—A destructive fire occurred at Rochester, New York State, estimated damage from five to seven million dollars.—Fifteen thousand men employed by the Buenos Ayres and Rosario railways go on strike.

27th.—A notice to workmen placed in certain Government dockyards explaining the premium system of payment for labour which is to be introduced experimentally at an early date.—Messrs. R. P. Houston and Co. establish a weekly service of steamers between Manchester and Hamburg.

29th.—Annual Conference of the South Wales Miners' Federation opens at Cardiff.—The New South Wales revenue for the past eight months amounts to £7,368,518.—The Buenos Ayres and Rosario Railway Companies refuse the strikers' demands; goods traffic is paralysed.

March.

1st.—The Inter-Colonial Council opens at Johannesburg to reconsider the financial position of the Transvaal and Orange River Colony in view of the declining railway receipts.

2nd.—Inauguration of a new steamship service between Glasgow and New Zealand ports by the Tyser Line.—Members of the Motor-Van and Wagon Users' Association hold their first general meeting.

3rd.—Launch of the new cruiser *Argyll* at Greenock.—Issue of a Blue-book relating to the Transvaal Labour Question.—Launch at Belfast of a four-masted steamship for the Bibby Line.

4th.—The strike among the Argentine Railway employees seems likely to extend.

5th.—Lord Chelmsford presides at the annual meeting of the United Service Institution.

9th.—The decision of the Inter-Colonial Council, Johannesburg, to reduce the capital expenditure on the open railway lines by £170,000, entails the suspension of work on the four lines under construction.—A French steamer founders off the coast of Cochin China—over a hundred lives lost.—The newly reconstituted Coal Conciliation Board meet under the presidency of Mr. Alfred Hewlett.

10th.—The national conference of coal miners of Great Britain, meeting at Westminster, unanimously resolve "to continue to protest against the tax on exported coal until the tax is repealed."—Mr. Roger Wallace presides at the annual meeting of the Automobile Club.—In the House of Assembly, Cape Colony, the Treasurer, making a provisional Budget statement, anticipates a deficit of £429,000 for the current year.

11th.—Labour Importation Ordinance receives the Royal sanction.—The Miners' Conference passes resolutions against the introduction of Chinese labour into the Transvaal, and the employment of foreign labour in British mines.

14th.—The Prince of Wales witnesses some manœuvres of submarines, destroyers and battleships off Sandown.

15th.—The Belgian Government place the installation of wireless telegraphy on board the Dover and Ostend boats at the disposal of the passengers.—A Select Committee of the House of Commons meet to consider a Bill sanctioning the rebuilding of Southwark Bridge at an estimated cost of £480,000.

16th.—The Institution of Civil Engineers holds its annual dinner in Lincoln's Inn—Sir W. White presiding—address by Mr. Arnold-Forster.—It is announced that the German Steel Trust is to negotiate with British and American steel companies with a view to obviating the existing competition.

17th.—Prince and Princess of Wales witness an exhibition of torpedo work by the Vernon Torpedo School at Portsmouth. Lord James of Hereford consents to continue the Chairmanship of the Coal Conciliation Board. Sir Hiram Maxim gives a demonstration of his new "captive flying machine" at Thurlow Park, Norwood. The Argentine Railway Strike terminates.

18th.—The British submarine A 1 is run down by a liner off the *Nab*, near Portsmouth—eleven lives lost.

19th.—Inauguration of the first section of the new Greek railway from Piræus to Demerli.

20th.—The American liner *New York* and the troopship *Assaye* in collision off the Isle of Wight.

21st.—Issue of Parliamentary paper giving full text of the regulations governing the recruiting of Chinese labourers.

NEW CATALOGUES AND TRADE PUBLICATIONS.

The Valor Company, Ltd., Rocky Lane, Aston Cross, Birmingham, forward descriptive circulars, illustrating their "Reform" and "Perfection" oil heating stoves, and the "Valor" perfection stove trays.

Bertrams, Ltd., St. Katherine's Works, Sciennes, Edinburgh, send us their new sheet of illustrations of machine tools for shipyards and iron constructional works. A pocket price list, containing a great deal of useful information in small compass, has also been issued by this firm.

J. J. Stockall and Sons, Ltd., forward a pamphlet which invites us to "Stop and Think." The interior is devoted to a short talk on method, the Stockall time recorder, check machine, and watchman's detector, etc. In the back cover is fixed a postcard, which can be detached and forwarded to the firm by those in search of further information.

Thomas Broadbent and Sons, Ltd., Huddersfield.—A good deal is said from time to time about the excellence of American printing, but we doubt whether our transatlantic friends could turn out better work than the pamphlet on cranes, which has just been issued by this firm. The salient facts regarding the numerous cranes illustrated and described can be obtained in a few minutes. A further reference to this pamphlet will be found under "Catalogue Cover Designs."

Bullivant and Co., Ltd., London.—This firm has issued an attractive reprint of articles on recent ropeway systems, which they have constructed in the Anaimalai Hills (conveying timber), at Queensferry, Flint (conveying coal and depositing over a given area), and at Wylam-on-Tyne, for Newcastle and Gateshead Waterworks. The first of these originally appeared in PAGE'S MAGAZINE. There is an exceedingly attractive display of half-tone blocks, those on the cover being especially noteworthy.

Gibbons Bros., Ltd., Dudley, London and Manchester. — A well printed and illustrated list of elevating and conveying machinery reaches us from this firm. The illustrations are mostly from photographs of machinery in actual use, and cover a wide range. Attention is particularly drawn to the construction of the Gibbons' patent steel roller chain. This minimises the wear on the connecting pins and links, thereby increasing very greatly the life of the chain.

The Rubber Stamp Company, Erdington, Birmingham. We have received from this firm a very complete net price list of rubber endorsing stamps. This includes a large selection of useful commercial stamps. A special list of stamped brass letters and figures has been compiled for the benefit of engineers and iron founders. These are affixed to the pattern by ordinary pattern-maker's shellac or glue, or by brads through holes in the flanges. The catalogue includes particulars of technical diagram stamps, automatic numbering machines, perforating presses, ink pads, etc. The firm also issue a useful list of solid rubber type, which should be obtained and filed for reference.

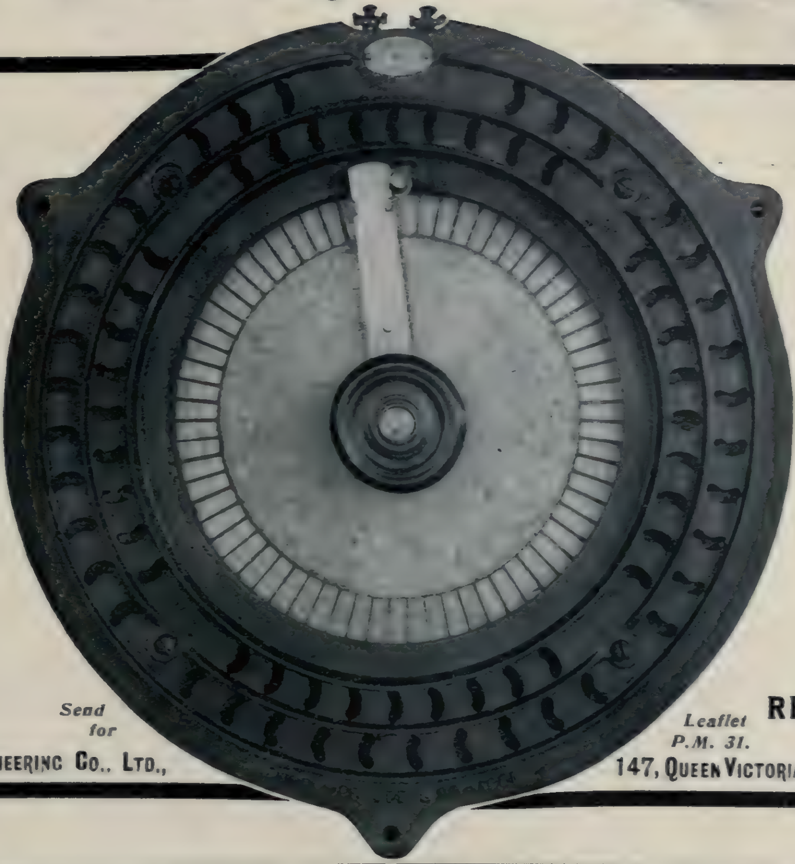
W. R. Renshaw and Co., Ltd., Stoke-on-Trent.—"A few types of Rolling Stock manufactured by W. R. Renshaw and Co., Ltd., Phœnix Works, Stoke-on-Trent" is the title given to this brochure, in which two dozen art sheets are bound up. The first illustration is that of a 30-ton all-steel bogie wagon, as built for the Caledonian Railway Company. Among others we notice an all-steel explosive oil-tank wagon, built to the latest requirements of the railway companies; a tarpaulin-covered wagon, for lime, stone, cement, etc.; a 30-ton refrigerator car, built to the Cape Government Railway's requirements; a 10-ton coal wagon, with "Accessible" type side doors; a 10-ton shipping wagon, fitted with Simpson's patent End Door catch; a 12-ton all-steel wagon, for carrying hot billets, rails, etc.; a 10-ton cattle van, as built for the Brecon and Merthyr Railway Company; contractors' tip wagons; and a steel-frame steel tank wagon to carry 20 tons of oil—altogether a very interesting and instructive collection.

Horace P. Marshall and Co.—An illustrated list of labour-saving foundry machines, including pneumatic hammers, sand rammers and moulding machines, hand-press moulding machines, plate moulding machines, core making machines, "Acme" roots positive pressure blower, pneumatic screen shakers, etc.

The Electrical Mining Company, Ltd., Derby. - Miners who are adopting electrical plant should obtain this company's 1904 pamphlet, which has some reading and illustrations interesting to practical men. In the course of an introductory note the company claim that the whole of the articles illustrated and described are the result of many years' experience of mining requirements, and may be relied on to give the maximum efficiency consistent with strength, durability, and, above all, safety. The company is confident that the day is not far distant when we shall see collieries fully equipped electrically; the steam plant consisting of winding engines, a fan engine, and electric power station, all within a few yards of the boilers, the auxiliary machinery being driven by electric motors, with the result of reduced attendance and higher efficiency all round.

Dean, Smith, and Grace, Ltd., Keighley. — One of the best machine tool catalogues that has lately reached us bears the name of this firm. It is devoted entirely to lathes, and includes an interesting description of the high-speed lathes to which the firm has given special study for a considerable time. The catalogue has an artistic embossed cover.

The British Thomson-Houston Company, Ltd. — This firm has issued a useful little pamphlet entitled, "Hints to users of Electric Light on the best means of securing Maximum Light at Minimum Cost." From this firm we have also received pamphlet No. 164, containing an illustrated description of their type H transformers.



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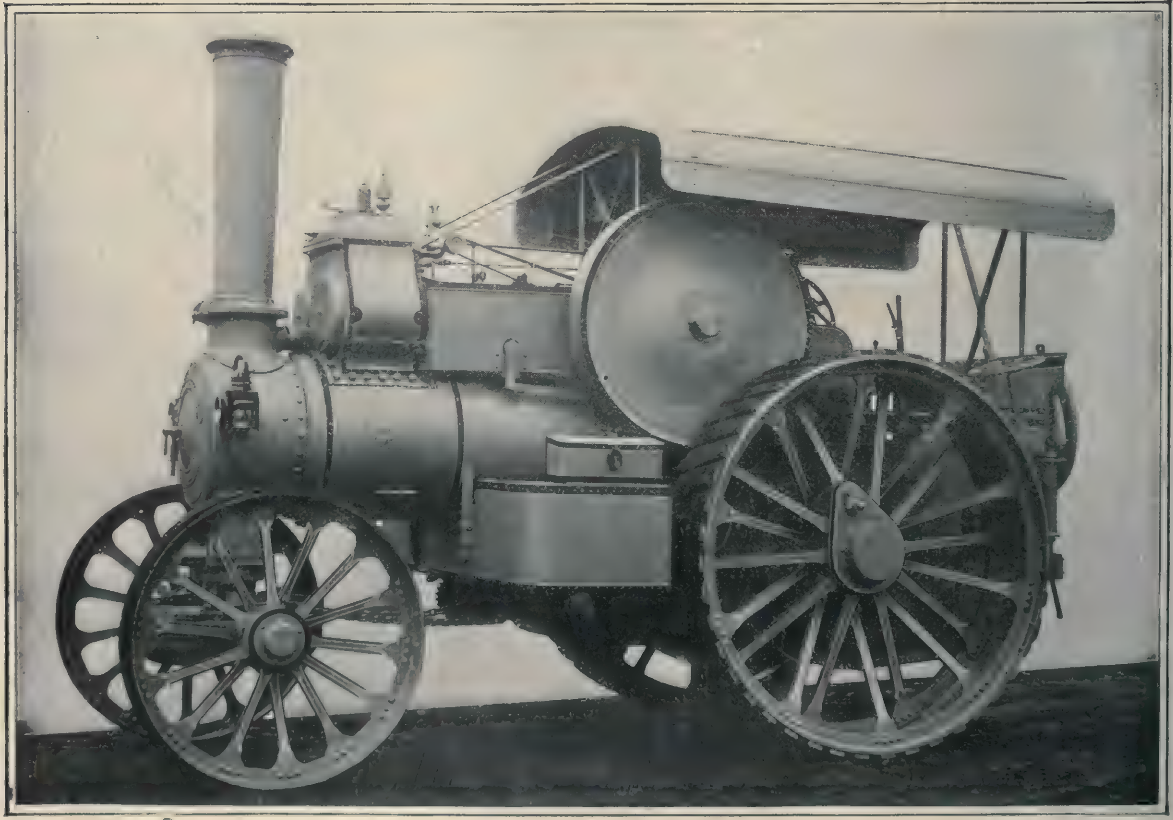

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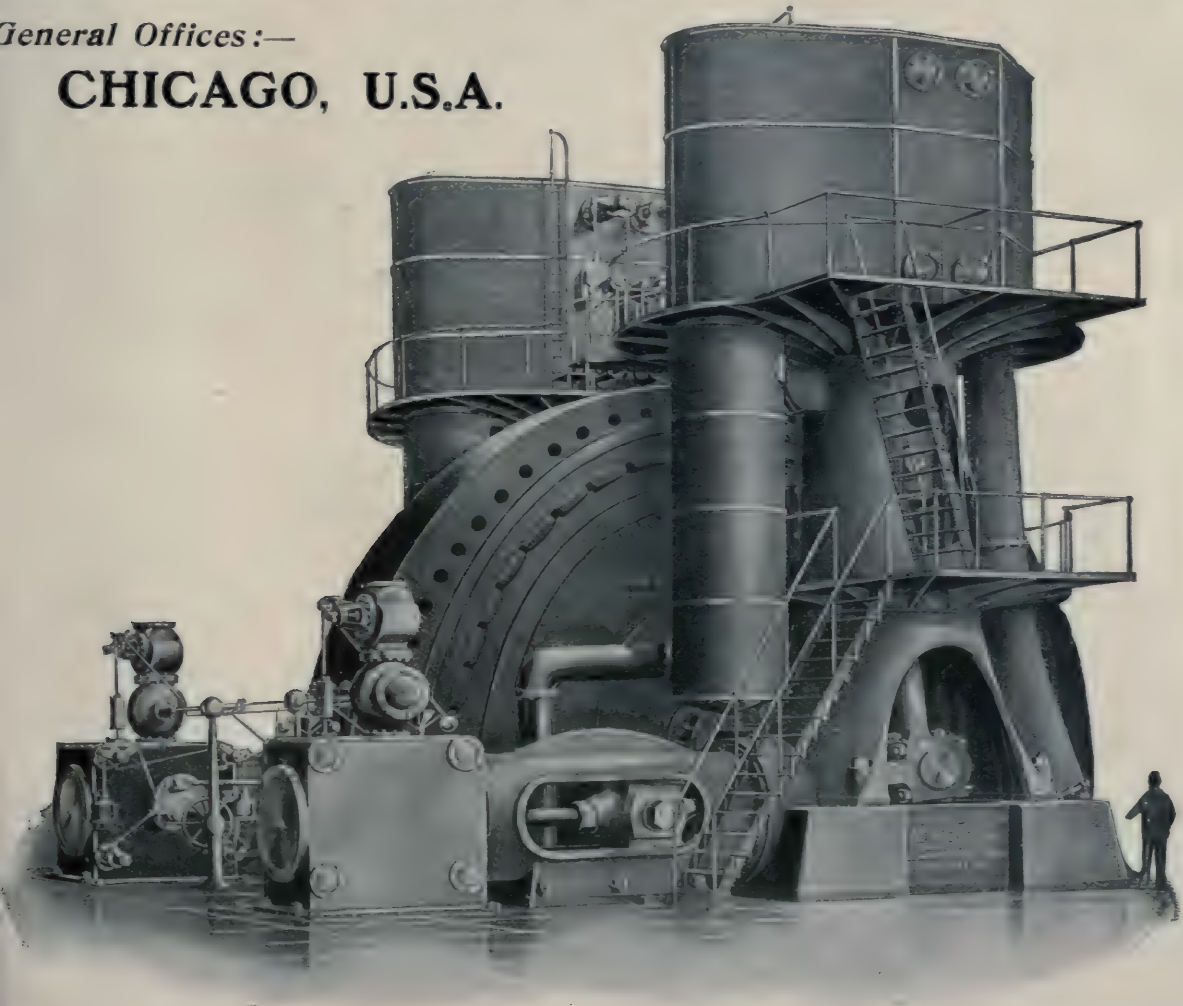

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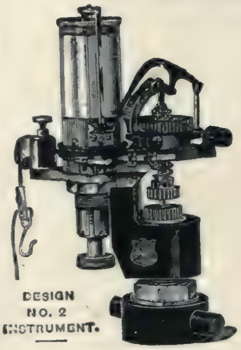

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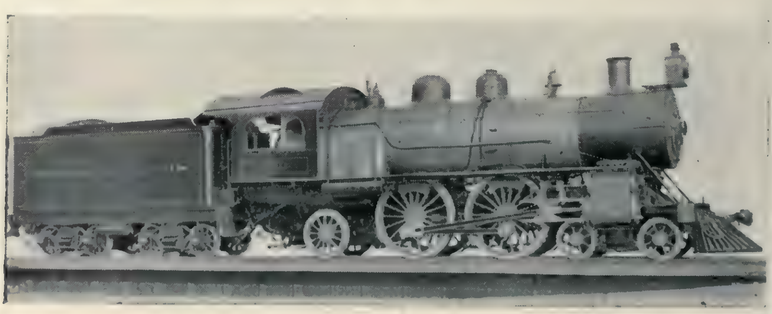

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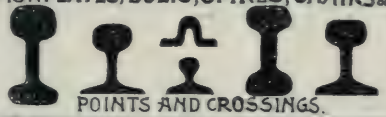

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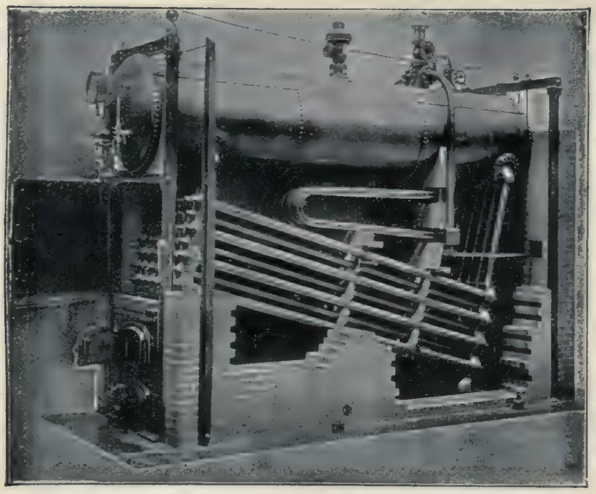

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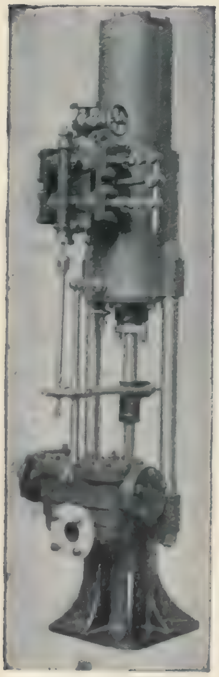

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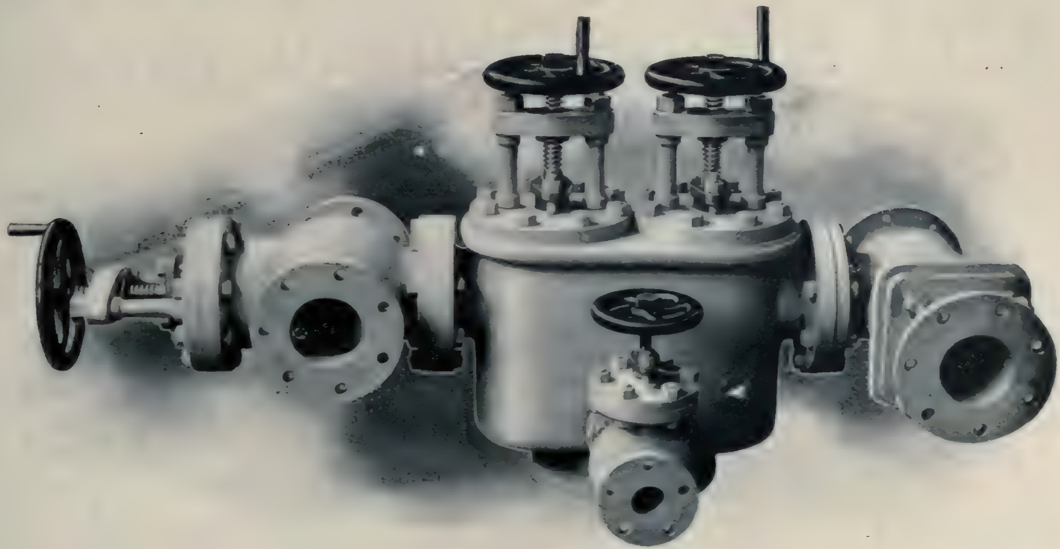

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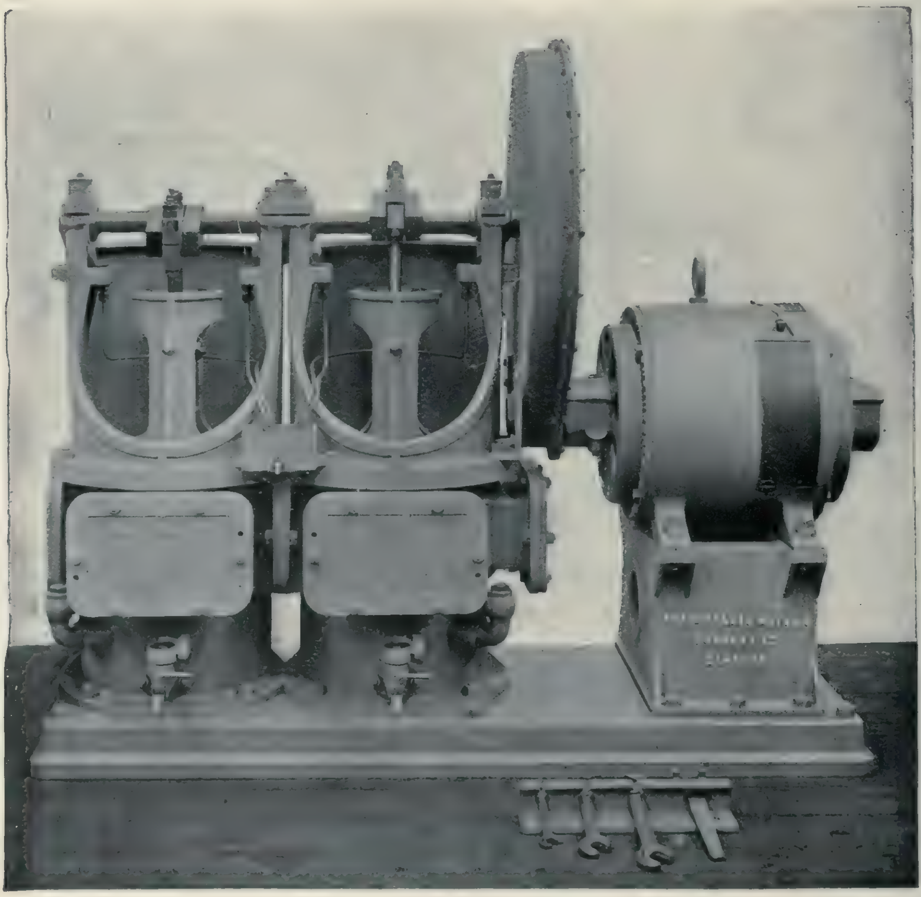

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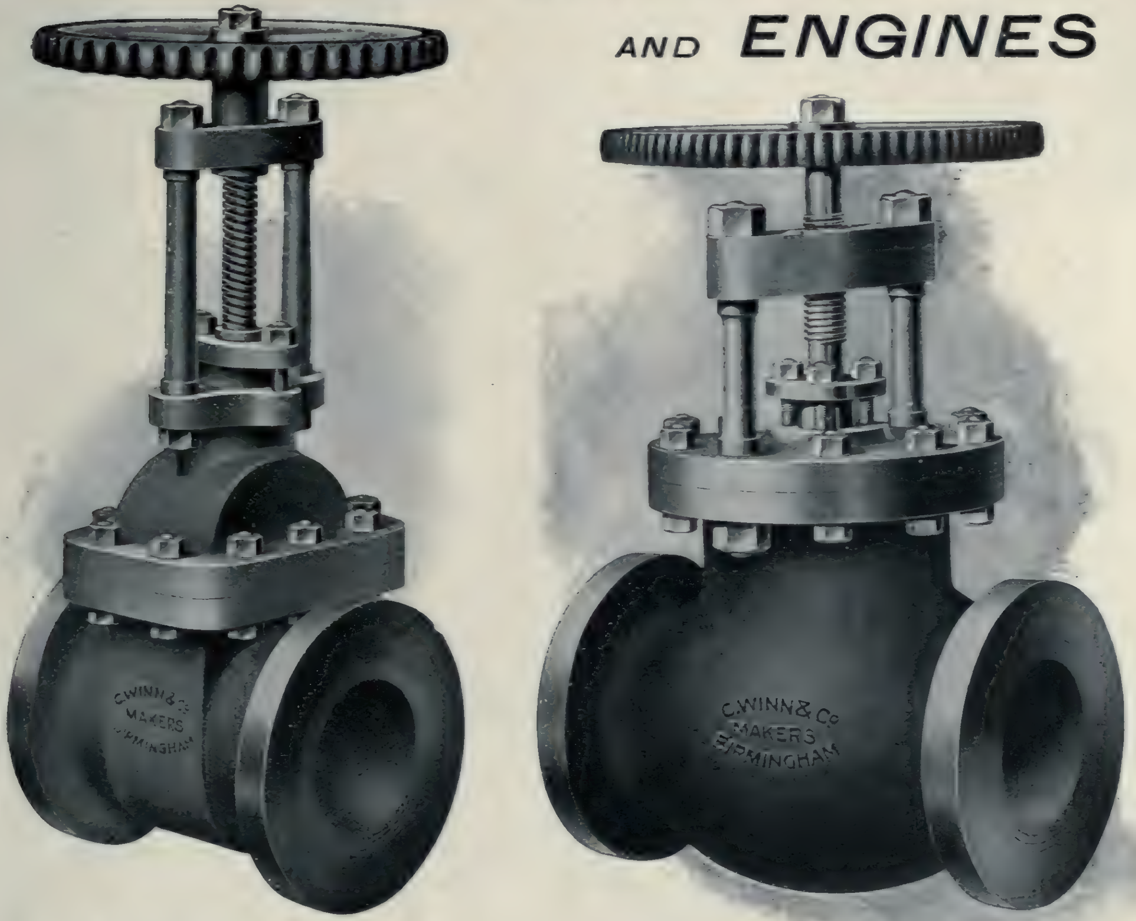

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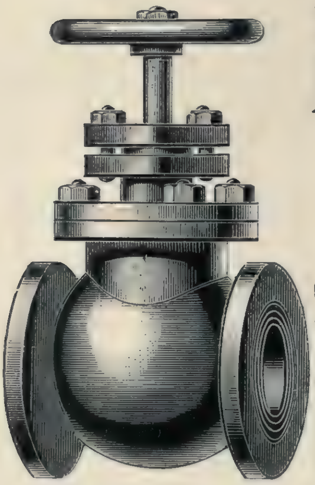

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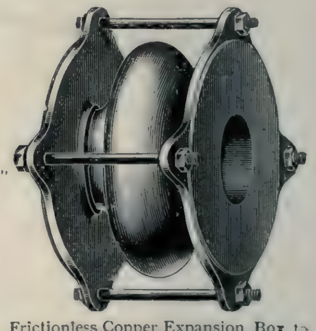

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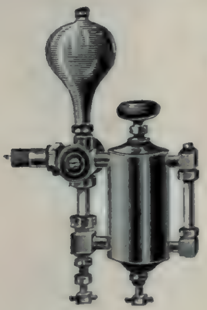

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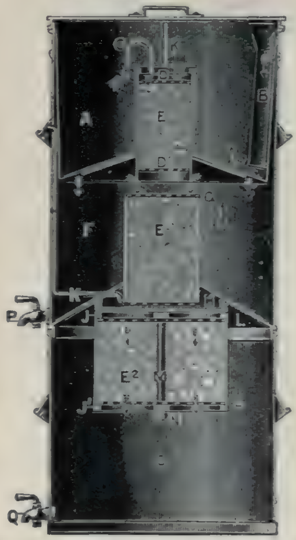

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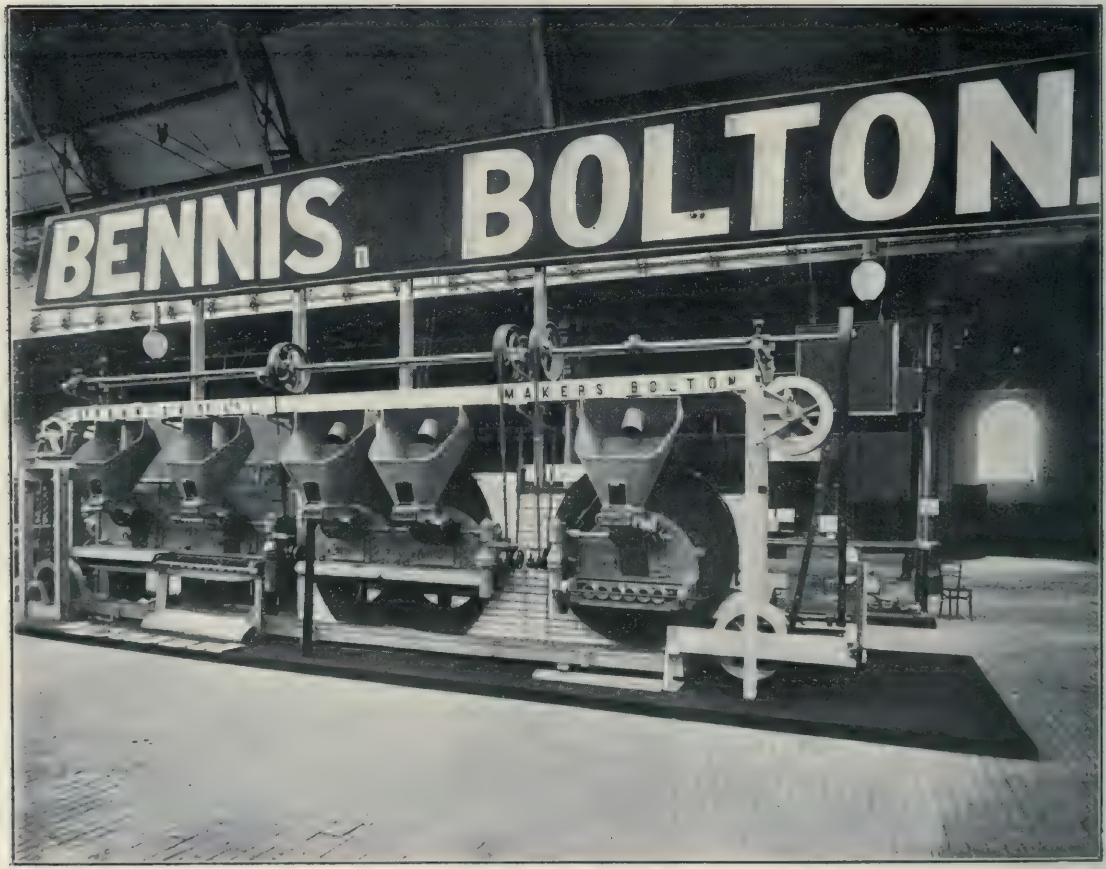

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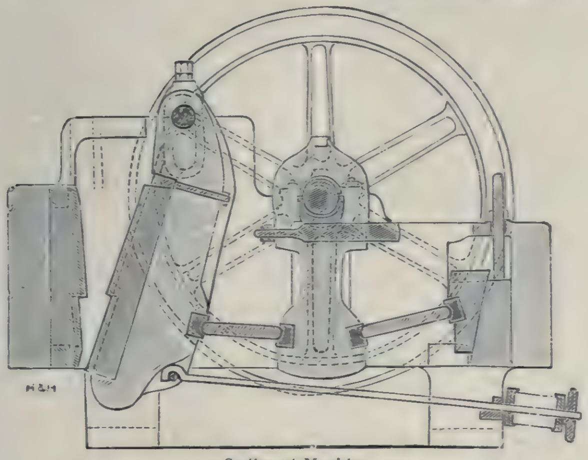

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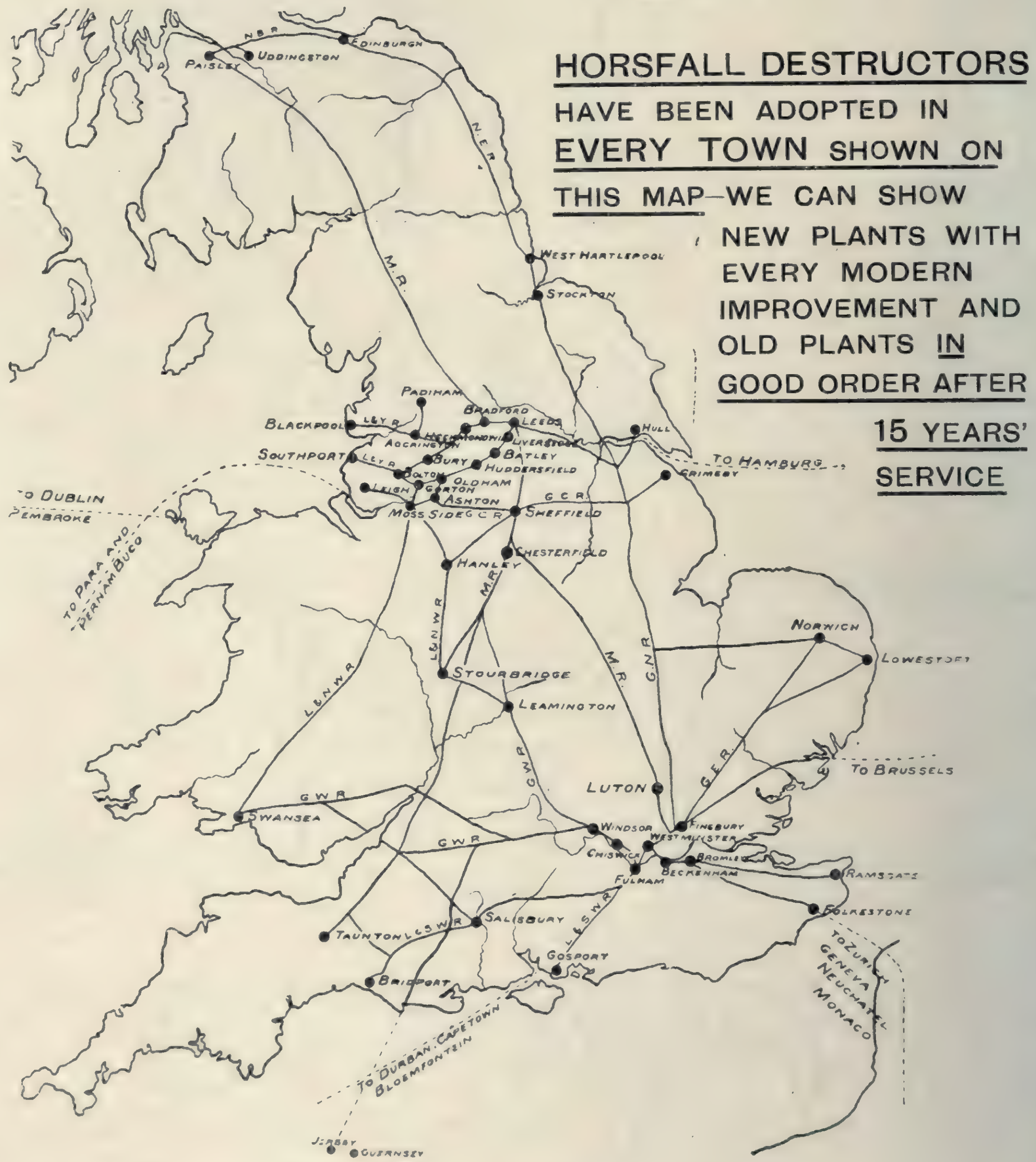

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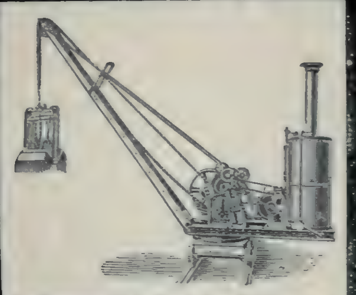

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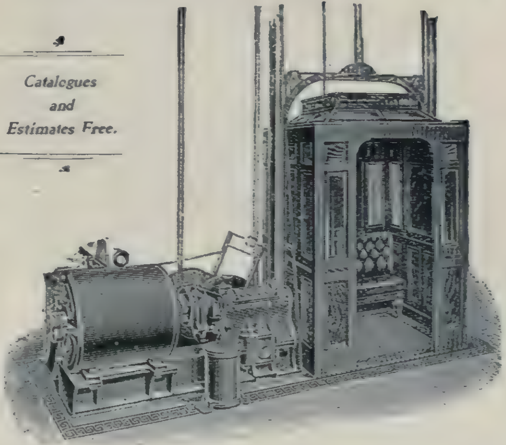

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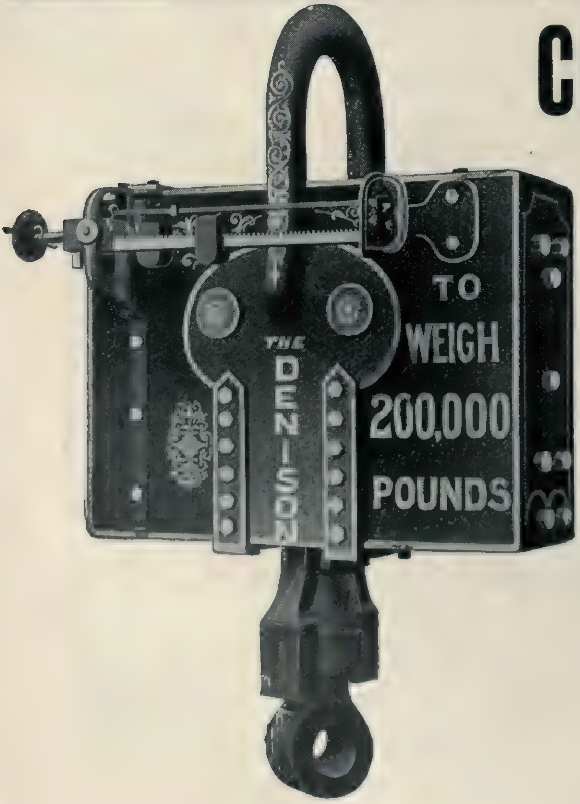

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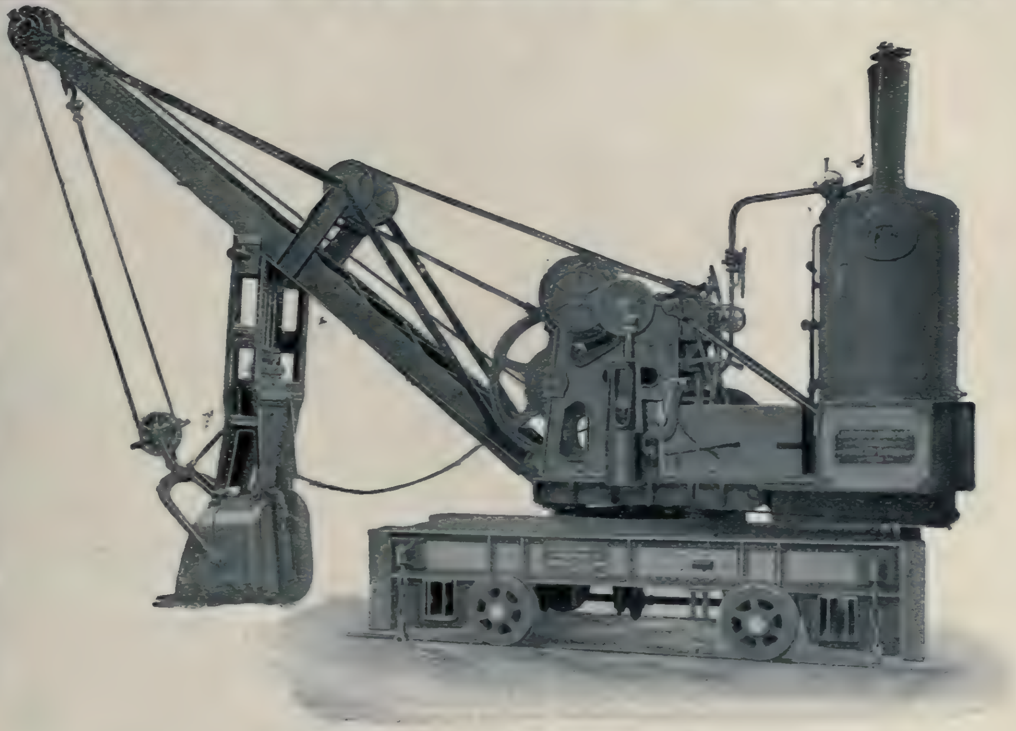

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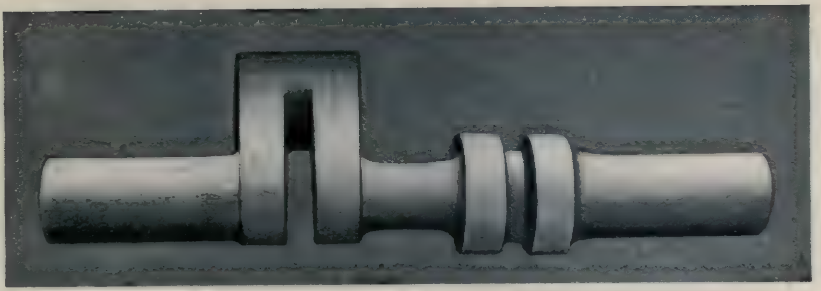

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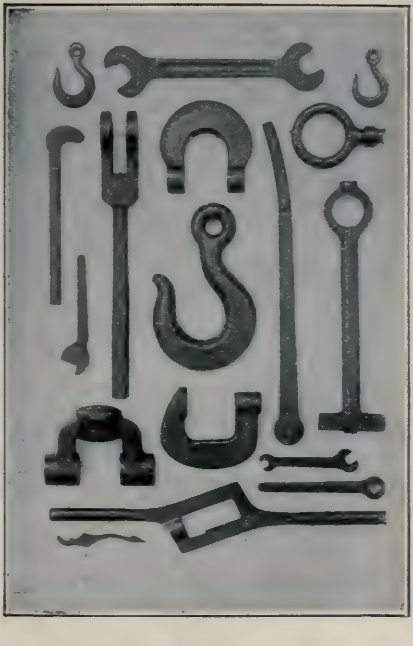

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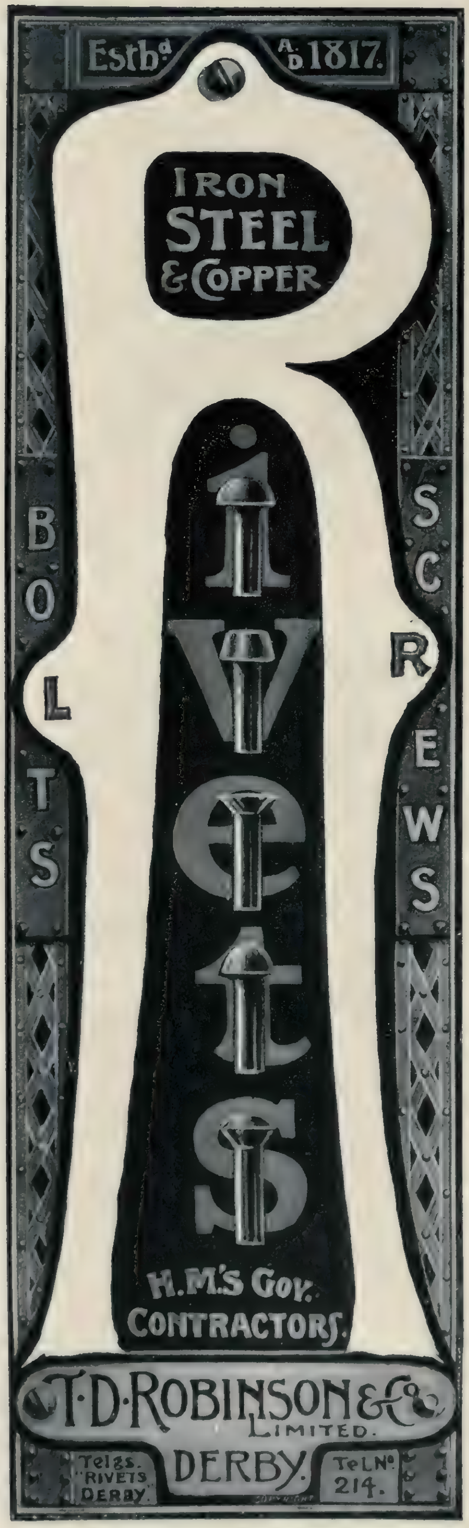

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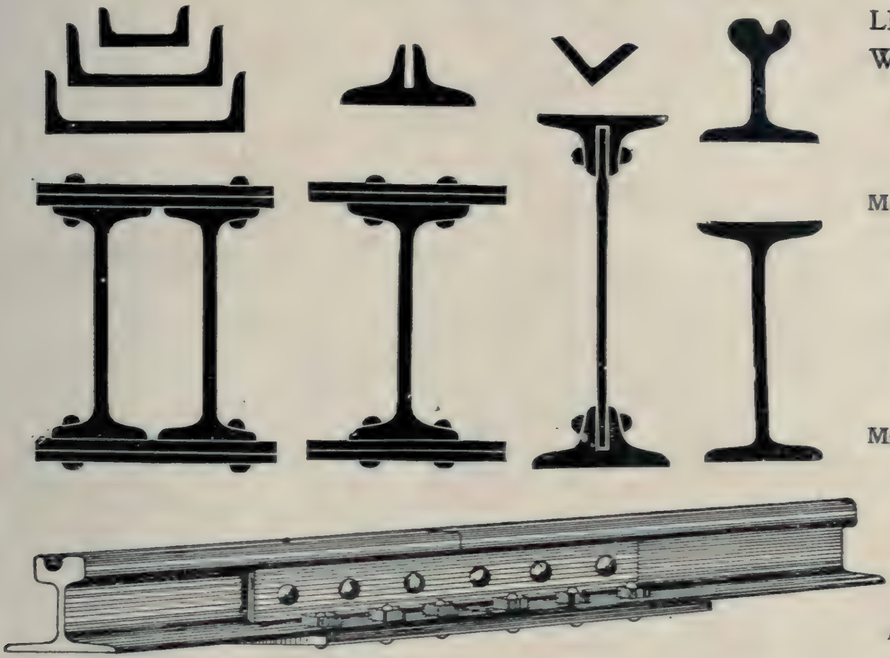

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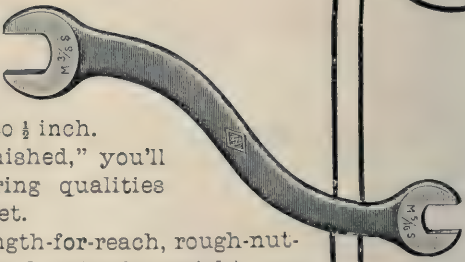

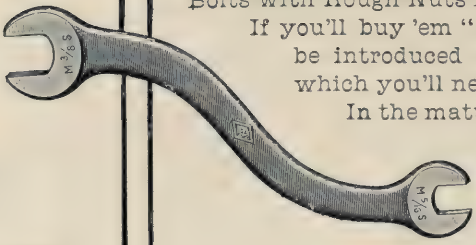

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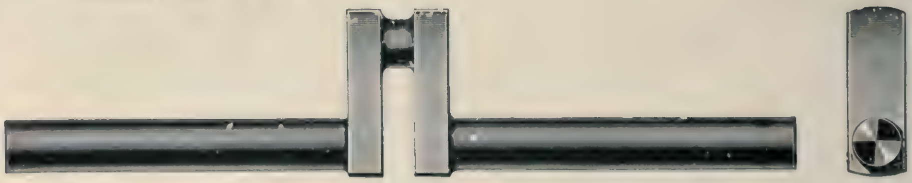

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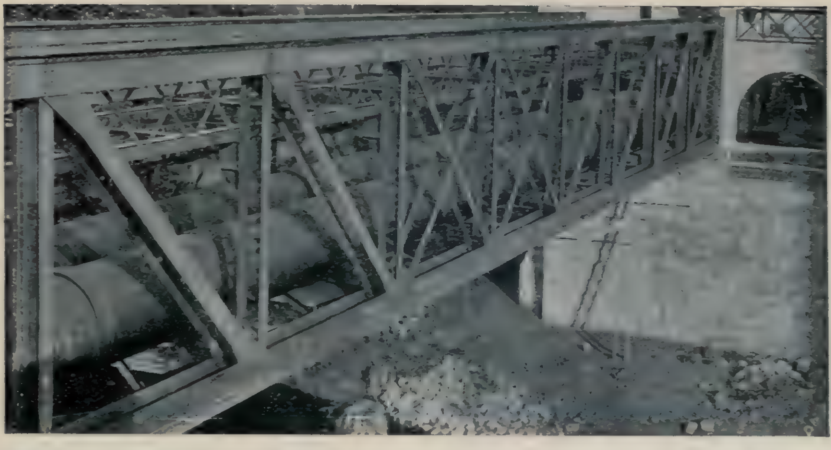

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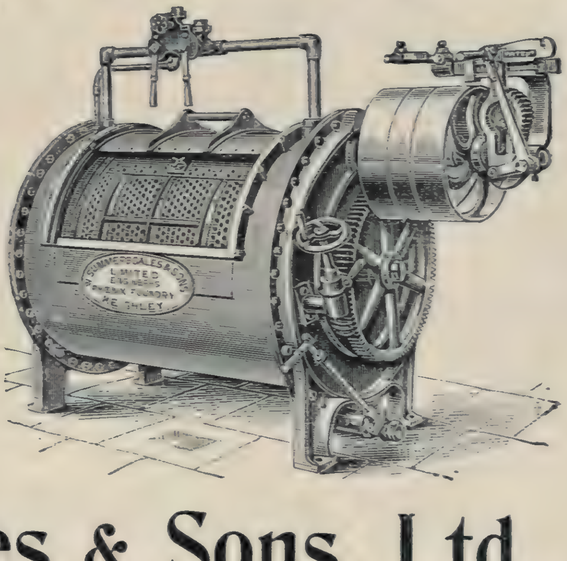
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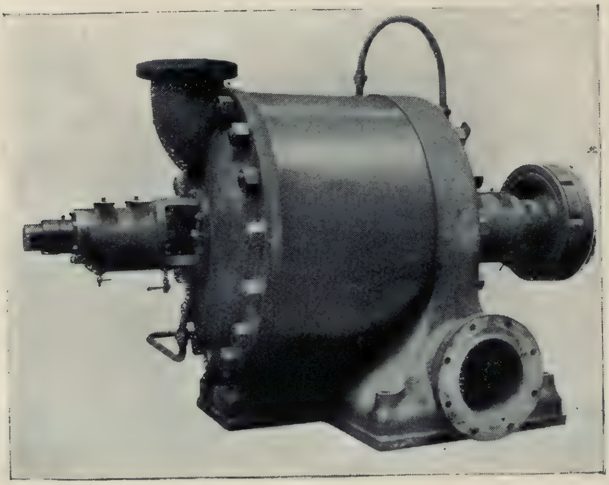

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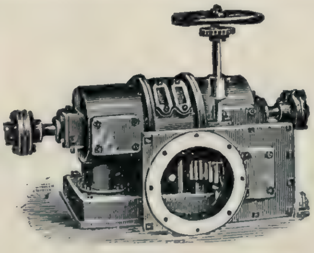

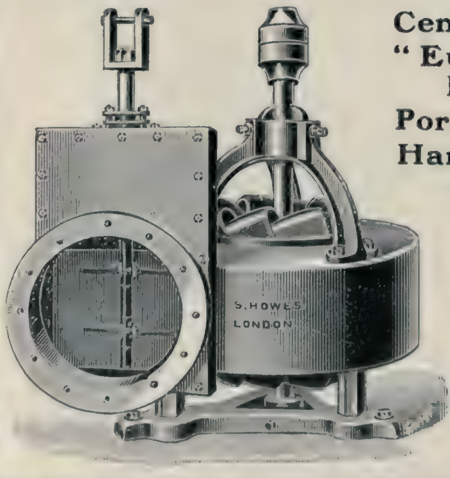

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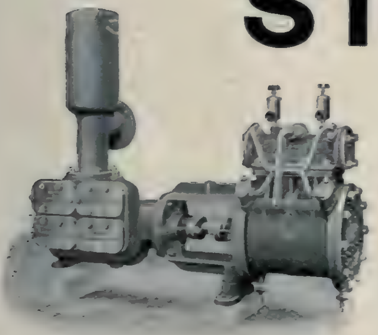

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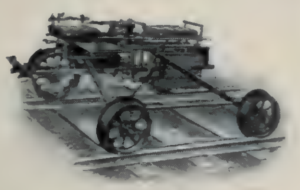

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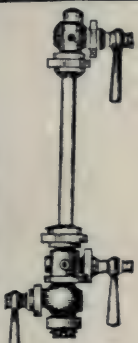

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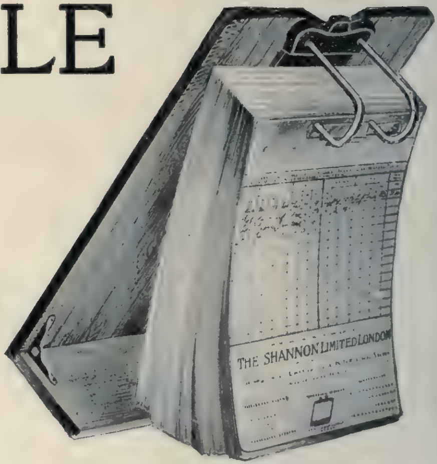

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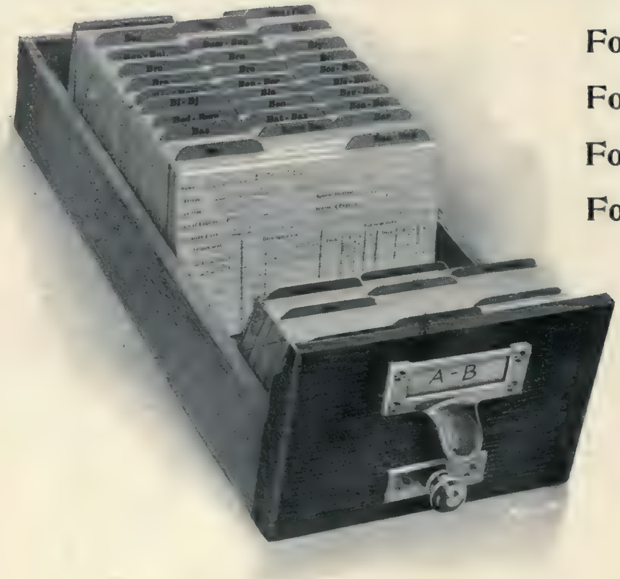

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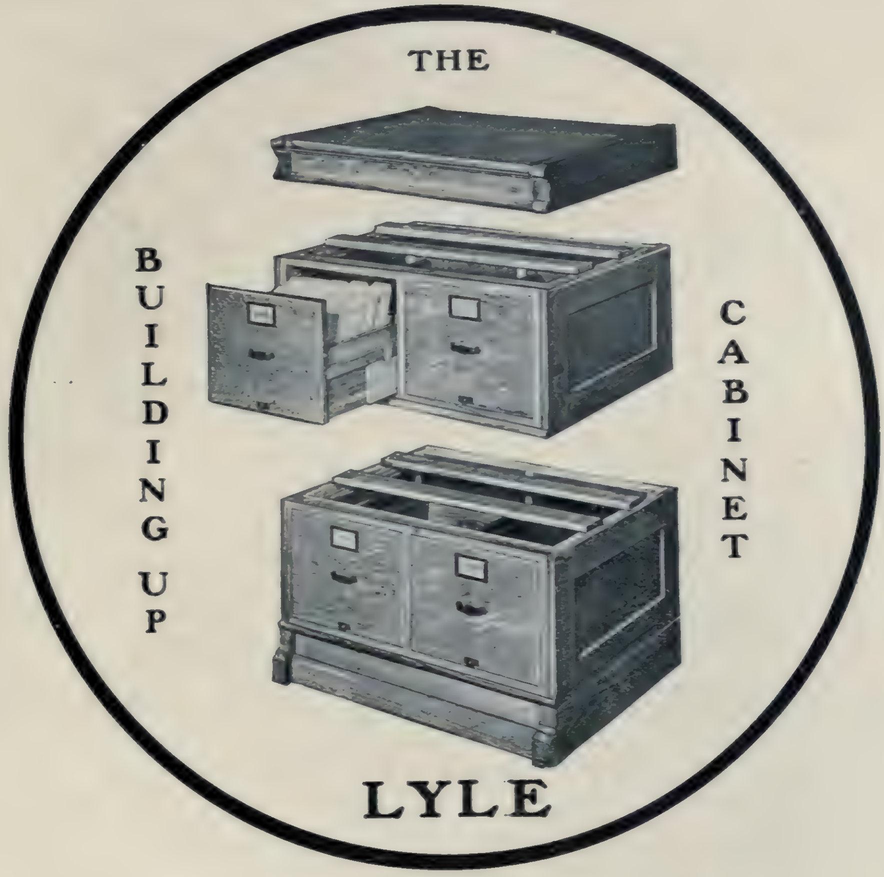

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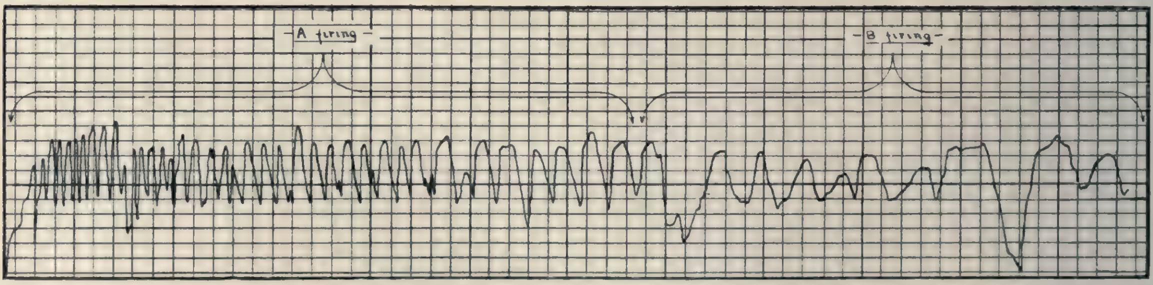

A and B, worked successively at an annealing furnace. While A was firing, the furnace received attention about every 25 minutes ; and while B was firing, the coaling took place about every hour. These facts, and the corresponding variations in the temperature of the furnace, are quite clearly seen from the accompanying illustration, which is a copy of the chart automatically registered by one of our CALENDAR RECORDERS, working in conjunction with an ELECTRICAL RESISTANCE THERMOMETER placed in the furnace.

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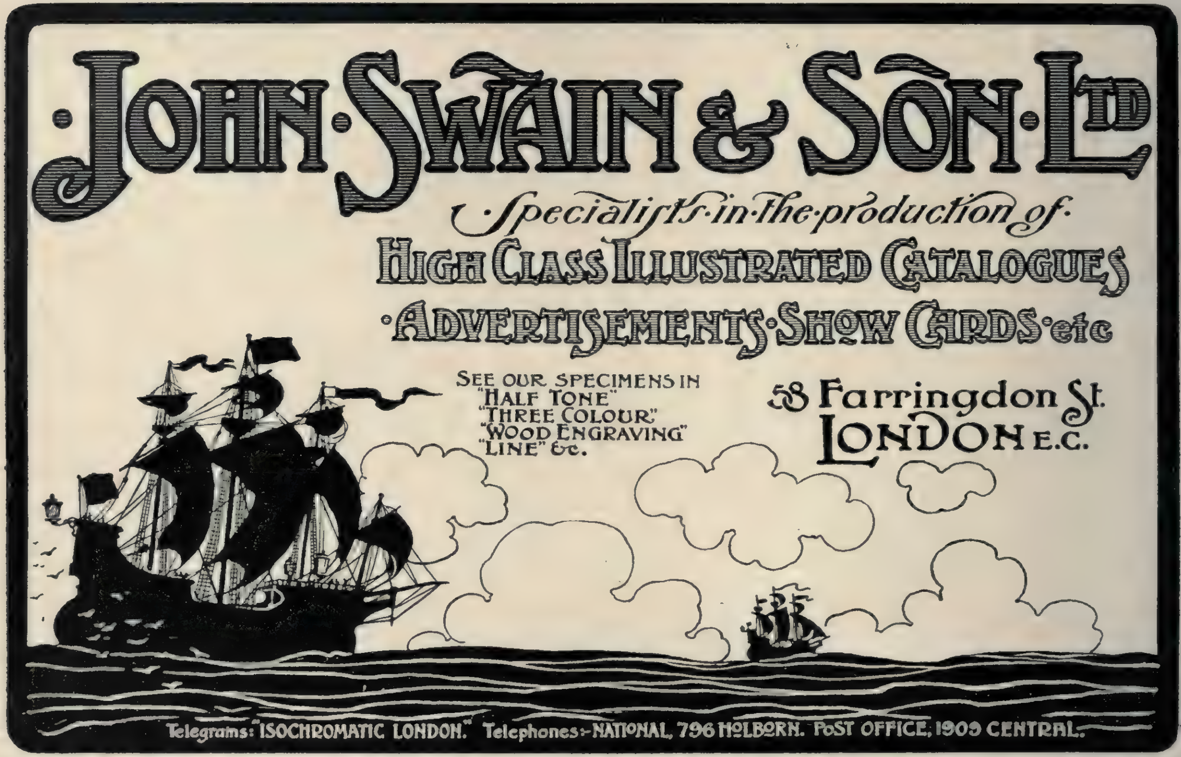

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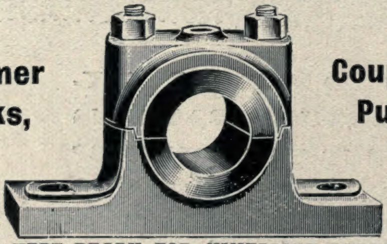

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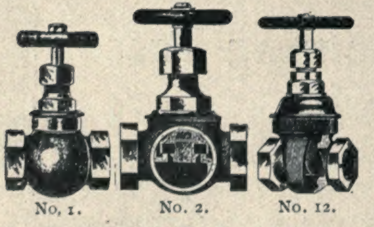

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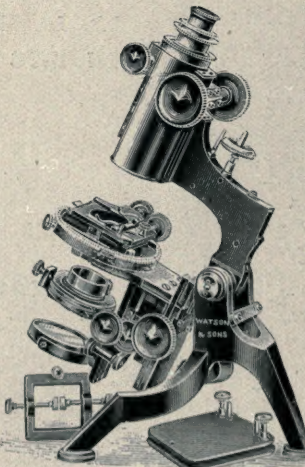

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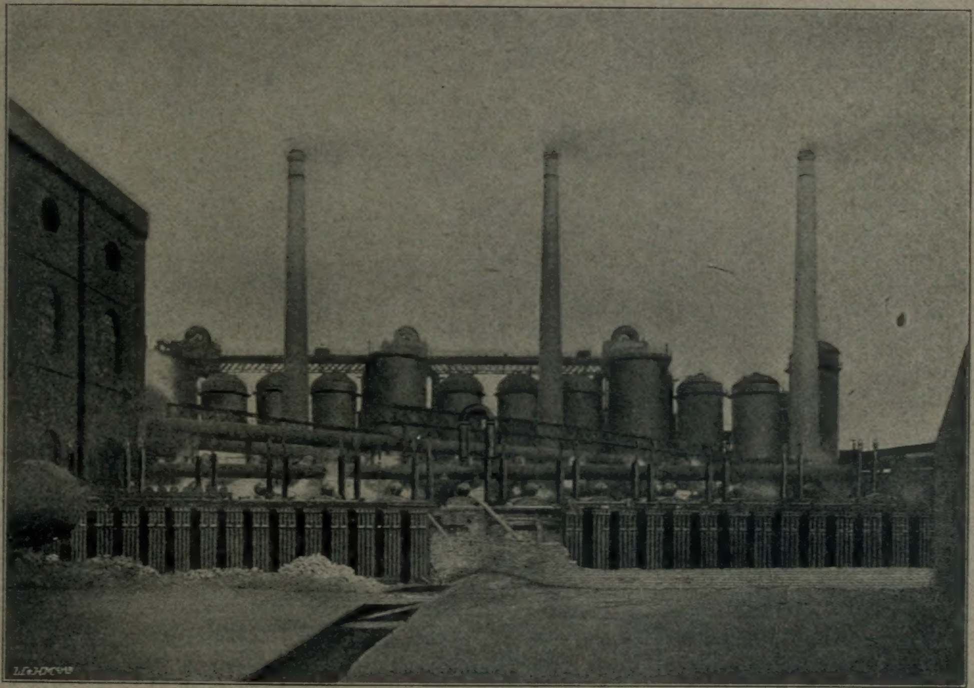

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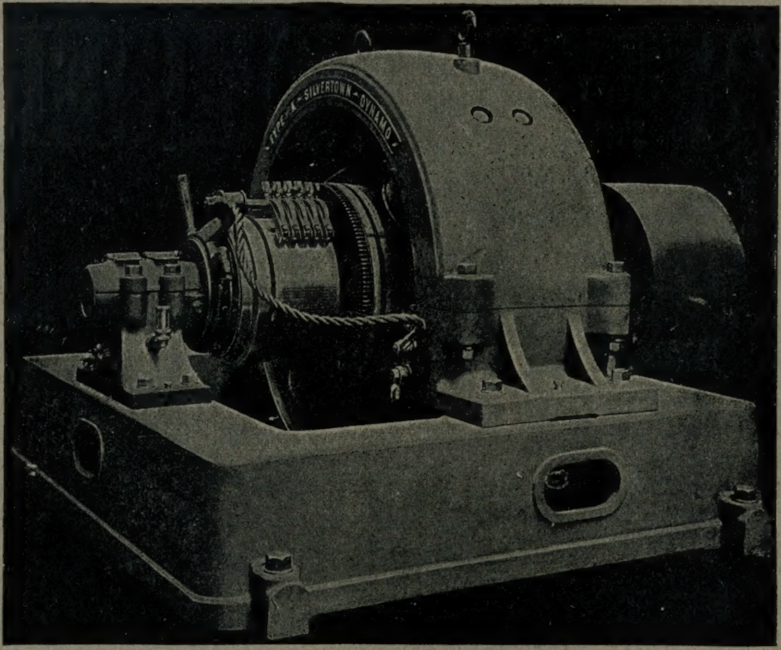

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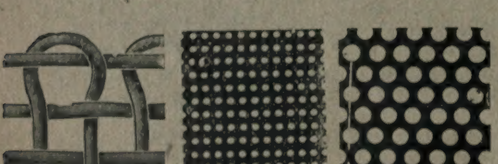

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